PROGRESS OF ASTRONOMY

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REPORTS

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OF

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OBSERVATORIES.

1879.

REPRINTED FROM THE REPORT OF THE SMITHSONIAN
INSTITUTION FOR 1879.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1880.

REPORTS OF AMERICAN OBSERVATORIES.

In the latter part of August, 1879, the following circular was sent to all known public and private observatories in America:

[CIRCULAR.]

SMITHSONIAN INSTITUTION,
Washington, D. C.

MY DEAR SIR: It is desired to present in the annual report of this institution a yearly summary of the state and progress of astronomy in the United States and elsewhere. To this end it is requested that the directors of observatories, public and private, will return this circular, with the blanks filled out and with such additional information as they may deem suitable for publication.

It is intended that one such circular shall reach every observatory, public or private, in the United States; if any have been omitted it has been by inadvertence, and notice of such ommissions is desired by the editor (Prof. EDWARD S. HOLDEN, U. S. Naval Observatory, Washington, D. C.).

It is proposed to continue the summaries in the future, and it is hoped that the directors of the various institutions will desire to furnish from year to year brief sketches of the activity of the observatories under their charge. In this way a record of current astronomical work will be kept up, which otherwise it is difficult to maintain in the absence of any American periodical specially devoted to astronomy.

Very truly yours,

SPENCER F. BAIRD,
Secretary Smithsonian Institution.

To ——— ———.

Replies to this circular have been received as below up to September 15, 1879. They are here arranged in the alphabetic order by towns.

Location of observatory: (City) Allegheny; (County) Allegheny; (State) Pennsylvania.

Name of observatory: ALLEGHENY OBSERVATORY.

Longitude from Washington, $11^m\ 50^s.84$ W.
Latitude, $40°\ 37'\ 47''.6$ N.

I. PERSONNEL:

Director, S. P. LANGLEY; *Assistant*, F. W. VERY.

II. INSTRUMENTS:

(*b*) *Meridian transit instruments:* Makers, TROUGHTON & SIMMS; aperture, 4 inches; magnifying power, 150 diameters.

(*c*) *Equatorial instruments:* Makers, FITZ, reworked by CLARK; aperture of objective, 13 inches; magnifying powers of eye-pieces, 50 to 1,200; equatorial carries a 12-inch flat mirror by CLARK at south end of its polar axis: also, position filar micrometer, polarizing solar eye-piece; apparatus for projecting solar image; eight other subsidiary pieces.

(*d*) *Spectroscopes:* One employing large RUTHERFURD grating; one with small grating; one 2-prism spectroscope; apparatus for using large equatorial as collimator, etc.

(*e*) *Photometers and other subsidiary apparatus:* A variety of thermopiles, used in connection with a THOMPSON reflecting galvanometer; large BUNSEN photometer; small portable heliostat, etc.

(*f*) *Chronographs:* One of BOND'S pattern, built by HAMBLET.

(*g*) *Clocks:* Mean time; two by HOWARD, both break-circuit: sidereal; one by FRODSHAM, break-circuit.

(*h*) *Chronometers:* Mean time; one by FRODSHAM: sidereal; one FRODSHAM, break-circuit.

(*i*) *Miscellaneous:* One reflecting telescope of 6½-inch aperture, specially used for obtaining an image projected any size without the employment of any enlarging lenses, and a number of subsidiary pieces for investigations in heat and light.

Electric appliances for the distribution of exact time, automatically and continuously to points outside the observatory.

III. OBSERVATIONS DURING THE PAST YEAR:

From September, 1878, to September, 1879.

(*b*) Nightly observations of from 3 to 6 stars for time determinations; observations to determine the longitude of Ebensburg, Pa.

(*c*) Daily map of solar surface, drawn by projection on a scale of 8 inches to diameter; enlarged drawings of any spots; measurements by thermopiles of heat of solar image; study of protuberances, and other work with attached spectroscopes.

(*d*) Studies of the lower end of the spectrum; mapping of lines in the extreme red, etc.

(*i*) Comparison of solar heat with that of the BESSEMER converter; the distribution of exact time to cities, railroads, corporations, or individuals.

IV. WORK PROPOSED FOR THE COMING YEAR, 1879-'80:

Systematic observation of sun as heretofore; continuance of researches now in progress, chiefly in solar physics; measurement of heat of diffraction spectrum by tasimeter, etc.; the continuance and extension of the "time-service."

V. PRINCIPAL PUBLICATIONS OF THE OBSERVATORY DURING THE YEAR 1879:

1. S. P. LANGLEY, on certain remarkable groups in lower spectrum, in Proceedings of American Academy.

2. S. P. LANGLEY, on comparison of sun, in Proceedings of American Academy.

3. S. P. LANGLEY, on BESSEMER converter, in Proceedings of American Academy.

4. S. P. LANGLEY, on electric time service, in Journal of Electrical Society.

Location of observatory: (City) Annapolis; (County) Anne Arundel; (State) Maryland.

Name of observatory: U. S. NAVAL ACADEMY OBSERVATORY.

Longitude from Washington, E. $0^h\ 2^m\ 15^s.91$.
Latitude N. 38° 58′ 53″.5

Authority for latitude and longitude: latitude, Professor CHAUVENET; longitude, United States Coast Survey.

I. PERSONNEL:

Lieutenant Commander ALLAN D. BROWN, U. S. N., head of Department Astronomy, Navigation, etc.

Assistants: 1. Lieutenant Commander CHAS. J. TRAIN, Instructor Astronomy, Navigation, etc.
2. Lieut. RAYMOND P. RODGERS, Instructor Astronomy, Navigation, etc.
3. Lieut. WM. J. BARNETTE, Instructor Astronomy, Navigation, etc.

II. INSTRUMENTS:

(*a*) *Meridian circles:* 1; maker, REPSOLD; *diameter of circles*, 28.7 inches; divided to 2′; read by four microscropes to 2″. *Aperture of objective*, 4 inches; for observations of the sun, aperture employed, 4 inches; magnifying power ordinarily employed, about 200 diameters.

(*c*) *Equatorial instruments:* Makers, ALVAN CLARK & SONS; aperture of objective, 7.75 inches; magnifying powers of eye-pieces, 40, 106, 553, 966; micrometer eye-pieces 89, 226, 673.

(*f*) *Chronographs:* One MORSE fillet; one Transit of Venus Commission.

(*g*) *Clocks:* One sidereal; makers, ARNOLD, CHAS. FRODSHAM, 84 Strand, London.

(*h*) *Chronometers:* Mean time; makers, NEGUS, Nos. 1030, 1088, 1260; DENT 2099; HATTON, 262. Sidereal; maker, NEGUS, Nos. 1520, 1527.

(*i*) *Miscellaneous:* One Talcott's zenith telescope (WURDEMANN); one Transit of Venus telescope (STACKPOLE); portable transit (WURDEMANN).

III. OBSERVATIONS DURING THE PAST YEAR:

From October 1, 1878, to October 1, 1879.

(*a*) Stars and sun (for time).

(*i*) STACKPOLE zenith telescope for latitude (for purposes of instruction); portable transit for time (for same purposes).

IV. WORK PROPOSED FOR THE COMING YEAR: (1879–'80).

Same as during past year.

Location of Observatory: (City) Battle Creek; (County) Calhoun; (State) Michigan.

Name of Observatory: HIGH SCHOOL OBSERVATORY.

Longitude from Washington not determined.
Latitude, not determined.

I. PERSONNEL:

ARTHUR K. BARTLETT (private observer).

II. INSTRUMENTS:

(*a*) Meridian circles, 1.

Aperture of objective, 4 inches; for observations of the sun, aperture employed, 2 to 4 inches; magnifying power ordinarily employed, 75 diameters.

(*i*) Miscellaneous: The only instrument at present used in the "Observatory" is a 4-inch achromatic telescope, which was purchased by the board of education, about nine years ago, for the use of students and teachers in the high school. It was manufactured by PIKE, the New York optician, and is mounted upon a portable tripod stand, provided with all the necessary adjustments. For the general observations of astronomy, it is regarded as one of the best telescopes in this State. The two celestial eye-pieces belonging to the instrument disappeared mysteriously about three years ago, having been stolen from the case in which they were kept; and as they have not since been replaced, the telescope has remained in a crippled condition without them. But some new eye-pieces are to be ordered soon, with powers varying from 45 to 275, together with colored eye-screens for observing the sun, and a comet eye-piece, with large field and low power. A terrestrial eye-piece is at present being employed, with a power of about 75 diameters; but the telescope has been used to good advantage for observations of the moon, Jupiter's satellites, and star-clusters.

III. OBSERVATIONS DURING THE PAST YEAR:

A continual watch for meteors was made throughout the night of August 10, and a large number were observed between the hours of ten and eleven o'clock in the evening, but about midnight the moon made its appearance, and being near the "radiant" in Perseus, prevented any successful observations being made towards morning. More than one hundred shooting-stars were seen in the space of one hour before the moon interfered, and several bright meteors flashed across the sky, leaving luminous trains behind them, and presenting a fine appearance, notwithstanding the close proximity and brightness of the moon. Observations of the aurora were made on various occasions, although no extraordinary displays were seen; and on many successive evenings in March, the unusual and remarkable brightness of the zodiacal light was particularly noted.

The only systematic observations with the telescope since it was placed in the high-school building have been made by ARTHUR K. BARTLETT, of Battle Creek, who has used the instrument for practical purposes, and given private instructions to the students and others who are frequently entertained on pleasant evenings. This telescope has been used for various observations of the heavens. It was employed with success during the last transit of Mercury, on May 6, 1878, and the first external and internal contacts of the planet were well observed, but the last two were prevented by clouds. During the past year the instrument has been chiefly directed to observations of the various nebulæ, star-clusters, and the interesting phenomena of Jupiter's satellites. An occultation of the star Antares by the moon was observed, and several drawings of celestial scenery were made by the aid of the telescope.

IV. WORK PROPOSED FOR THE COMING YEAR (1879–'80):

It is expected that the telescope will be provided with new eyepieces of high power some time this fall, and when they are secured the instrument will be in much better working order, so that it can be used in many other practical observations, for which it is not adapted at present. During the coming year I propose to study the sun at frequent intervals, when the weather is favorable, and shall employ the high powers mostly for observations of the planets, various nebulæ, and close double-stars. I shall also devote much time to literary work, and intend to lecture some during the winter. Meteoric astronomy, which has been a subject of special interest to me for some time past, will receive a good share of my attention in the future. The charming system of Jupiter will be studied with much pleasure, as in the past, and I also intend to continue my sketches and drawings of interesting objects in the heavens.

V. PRINCIPAL PUBLICATIONS OF THE OBSERVATORY DURING THE YEAR:

My publications have consisted mostly of newspaper articles on various astronomical subjects, which have been prepared with the object of presenting to general readers the principles and wonders of the science, and also to keep them informed concerning many interesting phenomena of the heavens. Among the articles contribued by me to the press during the past five years, were the following: "Double Stars"; "The King of Suns"; "Shooting-Stars"; "The Zodiacal Light"; "A Look along the Zodiac"; "The Study of Astronomy"; "The Prince of Planets"; "The Ringed Planet"; "A Celestial Panorama"; "The Moons of Jupiter"; "The Harvest Moon"; "Venus in the Daytime"; "Prof. Richard A. Proctor"; "The Lunar Eclipse"; "Celestial Fireworks"; "Frost and Dew"; "The Planetary System"; "Motions of the Stars.' In 1877, I published a pamphlet of 36 pages, containing a lecture of mine on "The Science of Astronomy," embracing its sublimity, history' progress, wonders, and utility. The lecture was prepared for the purpose of popularizing astronomy and rendering it a subject of more general interest.

VI. ADDITIONAL INFORMATION:

There is no *regular* observatory in connection with the high school, but it consists of an apartment located on the third and upper floor of the building, in which the telescope is kept and the observations are usually conducted. Astronomy is taught only during the spring term, and but little interest is manifested in the study by the students, although they are permitted to use the telescope at any time. When the instrument is provided with higher powers it will be equal to any of its size in the State of Michigan and can be made to do some good service. I have already observed five new comets with it since 1873, two having been seen in one night--May 8, 1877. Among the comets observed were two discovered by Professor SWIFT, of Rochester, N. Y. The great work which I have had at heart has been to arouse an interest in the study of astronomy, as a means of culture, especially among the young, and to increase the small number of votaries in this science. To this end I intend to continue my lectures and articles in the press, and also to exhibit celestial objects of popular interest, on favorable occasions. I will doubtless be able to send you more valuable reports in the future.

Location of observatory: (City) Brooklyn; (County) Kings; (State) New York.

I. PERSONNEL:

Director, W. T. GREGG.

(c) *Equatorial instruments:* Maker, WILLIAM T. GREGG; aperture of objective, 6¼ inches; magnifying powers of eyepieces, 50 to 600.

VI. ADDITIONAL INFORMATION:

As I said last year, my observatory was built to facilitate corrections of objectives, primarily, but I have been prevented from using it at all thus far by reason of illness. I hope to be able to do something in the future worthy of reporting.

Location of observatory: (City) Brooklyn; (County) King's; (State) New York.

I. PERSONNEL:

Director, G. P. SERVISS.

II. INSTRUMENTS:

(*c*) *Equatorial instruments:* One telescope; maker, JOHN BYRNE, of New York; aperture of objective, 3⅜ inches; magnifying powers of eye-pieces, 50, 106, 160, 250, and 320.

(*i*) *Miscellaneous:* My telescope is mounted equatorially on a tripod stand. The objective is of excellent quality. I can see the companion of *a* Lyræ and both the debilissima in Epsilon Lyræ with ease. It also easily separates double stars only 1.″5 apart. Under favorable circumstances I have seen five of Saturn's moons. I have no observatory, and my observations are made from lofty windows having a southerly and westerly exposure, and occasionally from the roof of my residence on Brooklyn Heights. In observing Jupiter and Saturn I ordinarily employ powers of 160 and 250, and occasionally 320. For special purposes I have used a power of 480 with good effect.

III. OBSERVATIONS DURING THE PAST YEAR:

From June, 1878, to September, 1879.

I have devoted most of the time spent with my telescope to viewing the moon and the planets, especially Jupiter and Saturn. I have made drawings of the surface of Jupiter at different times, noting every change in the belts and spots as accurately as possible. In August of this year (1879) and thus far in September I have made careful drawings of the disk of Jupiter and have colored them, seeking to give as near the exact tint as possible to the spots, belts, and shaded regions. The general result of my recent work shows that the northern dark belt is of a coppery hue, verging on a reddish-purple, while the southern belt is gray. The contrast in the color of these two belts has often appeared to me very strikingly. Their outlines are at times broken, and the copper belt is frequently seen split lengthwise. White and dark spots on the central light zone I have observed frequently.

IV. WORK PROPOSED FOR THE COMING YEAR (1879–'80):

I intend to continue my observations and drawings of Jupiter and other planets. I am especially interested in watching a remarkable elongated spot of a light maroon color (with a trace of rose tint) that lies south of the gray belt, and is about one-fourth of the planet's diameter in length, one-eighth of its own length broad, and somewhat rounded at the ends. The gray belt opposite this spot seems to grow narrower and bend away from the spot toward the center of the disk. All of my drawings show light and dark markings on the central white zone about in the longitude of this great spot.

173 GATES AVENUE, BROOKLYN.

I have been trying in vain nearly a year to obtain the Harvard Vol. IX, to aid me in photometric work. Hope to get it soon. For that reason, and from other business, my observatory has remained idle this year and does not deserve a place in your notices. I hope to resume work next year; but my eyes need rest, and do not seem to improve in this long astronomical recess.

Yours, truly,

HENRY M. PARKHURST.

Location of observatory: (City) Buffalo; (County) Erie; (State) New York.

Longitude from Greenwich, 78° 53′ 26″.5.
Latitude, 42° 54′ 9″.5.

Authority for latitude and longitude: Regents of University of State of New York. Report for 1862.

I. PERSONNEL:

Director, HENRY MILLS.

II. INSTRUMENTS:

(*c*) Telescope not equatorial; maker, Bardon; aperture of objective, 3 inches; magnifying powers of eyepieces, 50 to 250.

III. OBSERVATIONS DURING THE PAST YEAR:

Observations on sun spots and such other celestial phenomena as come within range of my instrument.

IV. WORK PROPOSED FOR THE COMING YEAR (1879–'80):

I propose to make systematic observations on sun spots and to record the same for future reference.

Location of observatory: (City) Cambridge; (County) Middlesex; (State) Massachusetts.

Name of observatory: The Astronomical Observatory of Harvard College.

Longitude from Washington, — $0^h\ 22^m\ 41^s.11$.
Latitude + 42° 22′ 48″.1.

Authority for latitude and longitude: American Ephemeris for 1881.

I. PERSONNEL:

Director, EDWARD C. PICKERING.

Assistants, WILLIAM A. ROGERS, A. M.; ARTHUR SEARLE, A. M.; LEONARD WALDO, S. D.; FRANK WALDO, S. B.; Miss R. G. SAUNDERS; WALTER HOXIE; J. F. MCCORMACK; WINSLOW UPTON, A. M.; OLIVER C. WENDELL. About half a dozen other persons are employed in computations.

II. INSTRUMENTS:

(*a*) *Meridian circle:* Makers, TROUGHTON & SIMMS (glasses by ALVAN CLARK & SONS); diameter of circles, 36 inches; divided to 5′; each circle read by 4 microscopes to 0.1″. Aperture of objective, 8¼ inches; for observations of the sun, aperture employed, 8¼ inches; magnifying power ordinarily employed, 300 to 350 diameters.

(*a′*) East transit circle, by TROUGHTON & SIMMS; diameter of circles, 48 inches; divided to 5′; each circle read by 4 microscopes to 0″.2. Aperture of objective, 4¼ inches.

(*b*) *Meridian transit instruments:* Maker, HERBST, of Pulkowa; aperture, 2¾ inches; magnifying power, up to 200 diameters.

(*b′*) Large photometer, mounted in the meridian, for comparing images of stars during transit.

(*c*) *Equatorial instruments:* Maker, MERZ; aperture of objective, 15 inches; magnifying powers of eyepieces, 100 to 2000.

(*c′*) West equatorial, by ALVAN CLARK & SONS; aperture, 5¼ inches.

(*d*) *Spectroscopes:* Three, described in Vol. VIII of the Annals of the Observatory.

(*e*) *Photometers and other subsidiary apparatus:* One ZÖLLNER photometer, and several photometers of other kinds.

(*f*) *Chronographs:* Two spring governors, by W. BOND & SON; one small barrel chronograph.

(*g*) *Clocks:* Mean time; maker, BOND, 394: sidereal; makers, FRODSHAM, 1327; BOND, 312.

(*h*) *Chronometers:* Sidereal; makers, FRODSHAM, 3451; BOND, 236; thermometric chronometer, FRODSHAM, 3424.

(*i*) *Miscellaneous:* Comet-seeker and other small telescopes and apparatus.

III. OBSERVATIONS DURING THE PAST YEAR:

From September 1, 1878, to September 1, 1879.

(*a*) Completion of observation of stars to the ninth magnitude, inclusive, in zone 50° to 55°; completion of observations of bright stars not recently well determined; commencement of observations of absolute places of important stars; observations for clock error, for use of time service (signals sent every two seconds to many points in and near Boston).

(*b*) Observations for clock error, as above.

(*b′*) Photometric comparisons of stars visible to the naked eye; the observing list includes about 4,000 stars.

(*c*) (*c′*) Photometric observations of satellites of superior planets; photometric observations of the eclipses of Jupiter's satellites; commencement of spectroscopic and photometric observations of selected nebulæ; observations of comets and asteroids.

IV. WORK PROPOSED FOR THE COMING YEAR (1879–'80):

Continuation of observations now in progress.

V. PRINCIPAL PUBLICATIONS OF THE OBSERVATORY DURING THE YEAR:

1. E. C. Pickering, annual report, 1878; published in 1879, vol. 1, page 14.

VI. ADDITIONAL INFORMATION:

Two volumes of the annals of the observatory are in course of publication.

The financial condition of the observatory has been greatly improved by the completion of a subscription to provide for its current expenses. This will be of important service in the reduction of a large accumulation of observations, the publication of which must otherwise have been long delayed.

A room has been fitted up for the purpose of making accurate measures of distance and comparisons of scales.

Location of observatory: (City) Chicago; (County) Cook; (State) Illinois.

Name of observatory: DEARBORN UNIVERSITY OBSERVATORY.

Longitude from Washington, + $0^h\ 42^m\ 14^s.26$.

Latitude, + 41° 50′ 01″.0.

Authority for latitude and longitude: American Ephem. and Naut. Almanac.

I. PERSONNEL:

Director, G. W. HOUGH.

II. INSTRUMENTS:

(*a*) *Meridian circles:* Makers, REPSOLD & SON; diameter of circle, 40 inches; divided to 2′; read by 4 microscopes to 0″.1; aperture of objective, 6 inches; for observations of the sun, aperture employed, 3 inches.

(*c*) *Equatorial instruments:* Makers, ALVAN CLARK & SONS; aperture of objective, 18½ inches; magnifying powers of eyepieces, positive, 120, 190, 287, 385, 900; negative, 135, 225, 450, 900.

(*f*) *Chronographs:* G. W. HOUGH; cylinder recording.

(*g*) *Clocks:* Mean time; Makers, HOWARD & CO.; GRAHAM escapement, mercury pendulum. Sidereal; Makers, CHARLES GORTNER & CO., London; GRAHAM escapement, mercury pendulum,

(*h*) *Chronometers:* Sidereal; Makers, BOND & SON.

(*i*) *Miscellaneous:* Signal mean time clock for transmitting time signals.

III. OBSERVATIONS DURING THE PAST YEAR:

From May 18 to ———.

(*a*) The Dearborn Observatory is not at present in active operation for want of funds. Observations are, however, made by the director as far as his time will permit.

(*c*) (*c′*) *Equatorial:* Observations on Tempel's comet; observations on Swift's comet; micrometrical measurements of the disk of Jupiter for figure now in progress. Mr. S. W. BURNHAM has the use of the equatorial for double-star work when it is not otherwise employed. Meridian circle used for time and the observation of stars for extra-meridian observations.

Location of observatory: (Village) Clinton; (County) Oneida; (State) New York.

Name of observatory: LITCHFIELD OBSERVATORY, of Hamilton College.

Longitude from Washington $0^h\ 6^m\ 34^s.65$ east.
Latitude $+\ 43°\ 3'\ 16''.5$

Authority for latitude and longitude: reports to the regents of the university of the State of New York.

I. PERSONNEL:

Director, C. H. F. PETERS.

No assistants.

II. INSTRUMENTS:

(*b*) *Meridian transit instruments:* Maker, WÜRDEMANN; aperture 2½ inches.

(*c*) *Equatorial instruments:* Makers, SPENCER & EATON; aperture of objective, 13½ inches; magnifying powers of eyepieces, 80 to 1,600.

(*c′*) Ditto, STEINHEIL, aperture 4 inches; altitude azimuth, SCHRODER, 5 inches aperture.

(*f*) *Chronographs:* WM. BOND & SON.

(*g*) *Clocks:* Mean time; makers, WM. BOND & SON.

(*h*) *Chronometers:* Sidereal; makers, WM. BOND & SON.

(*i*) *Miscellaneous:* For further details see catalogue of Hamilton College.

III. OBSERVATIONS DURING THE PAST YEAR:

(*b*) Time determination.

(*c*) (*c′*) Minor planets, comets, and zones of stars.

IV. WORK PROPOSED FOR THE COMING YEAR (1880):

Continuation of that of preceding year.

VI. ADDITIONAL INFORMATION:

[From January 1, 1879 to October 1, 1879, Dr. PETERS has discovered 7 asteroids, though he has omitted any notice of them from his report. This makes in all 38 asteroids discovered by him.—E. S. H.]

Location of observatory: (City) Columbia; (County) Boone; (State) Missouri.

Name of observatory: OBSERVATORY OF THE UNIVERSITY OF THE STATE OF MISSOURI.

Longitude from Washington, $1^h\ 1^m\ 6^s$ west.
Latitude 38° 56′ north.

Authority for latitude and longitude: JOSEPH FICKLIN and THOMAS J. LOWRY.

I. PERSONNEL:

Director, JOSEPH FICKLIN.
Assistant, THOMAS J. LOWRY.

II. INSTRUMENTS:

(*a*) *Meridian circles:* One; maker, BRUNNER, of Paris; diameter of circle, 10½ inches; divided to 5′; read by two microscopes to 3″; aperture, of objective, 2$\frac{1}{16}$ inches; for observations of the sun, aperture employed, 2$\frac{1}{16}$ inches; magnifying power ordinarily employed, 50 diameters.

(*c*) *Equatorial instrument:* Maker, HENRY FITZ, of New York; aperture of objective, 4$\frac{1}{16}$ inches; magnifying powers of eye-pieces, 30 to 240.

(*g*) *Clocks:* Mean time; maker, RIGGS, of Philadelphia; sidereal; makers, GREGG & RUPP, of New York.

(*i*) *Miscellaneous:* The instrumental equipment includes also a sextant, made by E. & G. W. BLUNT, of New York. The arc is graduated on silver, and reads by a vernier and microscope to 10 seconds. An altitude azimuth instrument, made by E. & G. W. BLUNT, of New York. It has an aperture of 2⅛ inches. The circles are 12 inches in diameter, and graduated to 10 minutes. The horizontal circle has four verniers with microscopes, and the vertical circle two; and each reads to 10 seconds. A transit theodolite, made by GREGG & RUPP, of New York.

III. OBSERVATIONS DURING THE PAST YEAR:

(*a*) Our observatory is used chiefly for instructional purposes. My time is so completely occupied by work in the class-room that I have very little time for original work.

IV. WORK PROPOSED FOR THE COMING YEAR (1879–'80):

The ordinary work of instruction to classes in astronomy, and a redetermination of our latitude and longitude.

Location of observatory: (City) Columbus; (County) Franklin; (State) Ohio.

Name of observatory: OHIO STATE UNIVERSITY.

I. PERSONNEL:

Director, R. W. MCFARLAND.

VI. ADDITIONAL INFORMATION:

I have no regular observatory yet, but have the private use of two telescopes, with which, in a small way, I am trying to get the authorities moved to do something worth reporting, which I cannot now do.

Location of observatory: (City) Elizabeth; (County) Union; (State) New Jersey.

Name of observatory: None.

Longitude from Washington, 2° 50′ 33″ east.
Latitude, 40° 40′ 19″ north.

Authority for latitude and longitude: United States Coast Survey.

I. PERSONNEL:

Director, CHARLES W. PLYER.

II. INSTRUMENTS:

(*b*) ***Meridian transit instruments:*** Makers, JOHN BLISS & SONS, New York; aperture, 1 inch; magnifying power, 10 diameters.

(*c*) ***Equatorial instruments:*** Maker, HENRY G. FITZ; aperture of objective, 6¼ inches.

(*c′*) Nine eye-pieces, from 50 to 630.

III. OBSERVATIONS DURING THE PAST YEAR:

(*c*) (*c′*) None, owing to ill-health, except an occasional search for comets.

IV. WORK PROPOSED FOR THE COMING YEAR (1879–'80):

Drawings of the surface of Mars, which will be a continuation of my work in 1877.

Location of observatory: (City) Fordham; (County) New York; (State) New York.

Private observatory.

Longitude from Washington, $0^h\ 12^m\ 40^s.47$ east.
Latitude, 40° 52′ 31″.3.

Latitude and longitude deduced from Coast Survey map of 1863 and American Ephemeris 1879, assuming the latitude and longitude of New York, given in the Ephemeris, to be the latitude and longitude of the City Hall.

I. PERSONNEL:

Director, WILLIAM MEIKLEHAM.

No assistants.

II. INSTRUMENTS:

(*c*) ***Equatorial instruments:*** Maker, JOHN BYRNE, of New York; aperture of objective, $4\frac{3}{10}$ inches; focal distance, 65 inches; magnifying powers of eye-pieces, 20, 30, 45, 60, 80, 150, 250, 300, 350, and 450; also an amplifier which doubles each of these powers when used. Attached to the telescope is a finder of 1½ inches aperture, magnifying 20 diameters. Right ascension circle divided to read to 4 seconds of time; declination circle divided to read to 1′ of arc. Both circles divided on silver and read by microscopes attached thereto. Driving-clock.

(*d*) ***Spectroscopes:*** One.

(*g*) ***Clocks:*** Mean time; Maker, SETH THOMAS, SONS & CO.

(*i*) ***Miscellaneous:*** Filar micrometer; divided on silver to measure $\frac{3}{10}''$ of arc in distance, and 6′ in position, with suitable eye-pieces and illuminating apparatus.

III. OBSERVATIONS DURING THE PAST YEAR:

From September 1, 1878, to September 1, 1879.

(*c*) Observations of the magnitudes and colors of double stars, lunar peaks and craters, solar spots and faculæ, belts of Jupiter, rings of Saturn. In solar observations I find it advantageous generally to reduce the aperature of my telescope to $3\frac{5}{10}$ inches, and use an eye-piece magnifying 80 diameters, with a right-angle prism instead of a colored glass screen.

(*i*) Measurements of position and distances of components of double stars; heights of lunar peaks by the lengths of their shadows; width of lunar craters; sizes of solar spots.

IV. WORK PROPOSED FOR THE COMING YEAR (1879–'80):

A continuation of the above.

Location of observatory: (City) near Fort Dodge; (County) Webster; (State) Iowa.

Longitude from Washington, $1^h.\ 8^m.5$ west.
Latitude, 42° 30′ north.

Authority for latitude and longitude, F. HESS.

I. PERSONNEL:

Director, F. HESS.
Assistant, Mrs. P. B. HESS.

II. INSTRUMENTS:

(*a*) Aperture of objective, $2\frac{5}{8}$ inches; for observations of the sun, aperture employed, $2\frac{5}{8}$ inches; magnifying power ordinarily employed, 50 diameters.

(*b*) *Meridian transit instruments:* Makers, J. BROWN & SON, New York; aperture, 1 inch; magnifying power, $10\frac{1}{2}$ diameters, with horizontal and vertical circle, each reading to 1.

(*g*) *Clocks:* Mean time; maker, G. M. WHEELER, Elgin, Ill.

(*i*) *Miscellaneous:* One TROUGHTON sextant and artificial horizon.

III. OBSERVATIONS DURING THE PAST YEAR:

From September 15, 1878, to September 15, 1879.

(*a*) Observations of sun-spots, occultations, eclipses of Jupiter's satellites, and searching for intra-Mercurial planets.

(*b*) (*b′*) Observing the variations of the magnetic needle, altitudes and azimuths, time, latitude and longitude, and approximately locating sun-spots.

(*i*) Observing altitudes, time, latitude and longitude of various places.

IV. WORK PROPOSED FOR THE COMING YEAR (1880):

Continuation of previous work and the establishment of an observatory on Mount Zapato, Colorado, located 5.9 miles S. $76\frac{1}{2}$ E. (M. B.) from

N. G. Adee's house at Zapato, and rising to an altitude of 6,120 feet above said house, the approximate elevation of which above sea-level is 8,009 feet, provided a valid title can be obtained by purchase or otherwise to sections 13 and 14, township 28 north, of range 73 west, of the sixth principal meridian, as yet unsurveyed and unoccupied public land comprising this mountain, the most accessible of the higher peaks of the Sierra Blanco.

V. Additional information:

April 25, 1879, I found Brorsen's comet in the vicinity of a star supposed to be B. A. C. 1504, coming within the same field of view of instrument (*a*), in which the comet was seen with a magnifying power of 50. The comet was observed each following night until April 30, when a star, supposed to be B. A. C. 1849, was within the same field of view with the comet. It was looked for again all night of May 5, but could not be found again.

During a few hours in the nights of July 18 and August 10, on the San Juan, below Pagosa Springs, Colorado, I saw many very brilliant meteors. Monthly reports of sun-spots and other miscellaneous observations have been made to the Chief Signal Officer of the Army.

Location of observatory: (City) Glasgow; (County) Howard; (State) Missouri.

Name of observatory: Morrison Observatory.

Longitude from Washington, $1^h\ 3^m\ 6^s.8$ W.
Latitude, 39° 16′ 16″.75 N.

Authority for latitude and longitude: Longitude by *time signals* from the Naval Observatory on five successive days; latitude from a series of observations on circumpolar stars made on meridian circle.

I. Personnel:

Director, Carr W. Pritchett.
Assistant, C. W. Pritchett, Jr.

II. Instruments:

(*a*) *Meridian circles:* makers, Troughton & Simms, London; diameter of circles, 24 inches; divided to 5′; read by 8 microscopes to 1″; aperture of objective, 6 inches; for observations of the Sun, aperture employed, 4 inches; magnifying power ordinarily employed, 200 diameters.

(*c*) *Equatorial instruments:* Makers, Alvan Clark & Sons; aperture of objective, 12¼ inches; magnifying powers of eyepieces, 50 to 1,000.

(*f*) *Chronographs:* by Alvan Clark & Sons, conical pendulum.

(*g*) *Clocks:* Sidereal, maker, Charles Frodsham, No. 1369.

(*h*) *Chronometers:* Sidereal, makers, T. S. & J. D. Negus, break circuit No. 1590.

(*i*) *Miscellaneous:* Small altazimuth, Casella, London; barometer and thermometer.

III. OBSERVATIONS DURING THE PAST YEAR:

(From September 1, 1878, to September 1, 1879.)

(*a*) Meridian circle has only been used for *time observations*.

1. Third series of observations on satellites of Saturn.
2. Observations of satellites of Jupiter.
3. Measures of position, angle, and distance of double and multiple stars.
4. In progress, an extensive series of observations on the Red Spot on Jupiter, first seen July 9, 1878. Transit of center, for redetermination of axial rotation.
5. A few occultations of stars by the Moon.

IV. WORK PROPOSED FOR THE COMING YEAR: (1880.)

(*a*) It is expected that the meridian circle will be put to systematic use during the ensuing year.

(*c*) The observations on the equatorial will be divided between the fixed stars and planets as the *relative* importance of the work, for the time being, may demand.

VI. ADDITIONAL INFORMATION:

We have no fund for defraying expenses of publications. A few papers have been published in the "Astronomische Nachrichten" and the "Observatory," London. There exists here quite a large number of observations which might be of use if published.

Location of observatory: (City) Hanover; (County) Grafton; (State) New Hampshire.

Name of observatory: SHATTUCK OBSERVATORY.

Longitude from Washington, $19^m\ 3^s.56$ east.
Latitude, 43° 42′ 15″.2 north.

Authority for latitude and longitude: Prof. C. A. Young.

I. PERSONNEL:

Director, CHARLES F. EMERSON.

Assistants: 1. CHARLES D. LAMB, } Room in the observatory, and have charge of the meterological observations.
2. DAVID R. REED, }
3. GEORGE O. MITCHELL.

II. INSTRUMENTS:

(*a*) *Meridian circles:* makers, TROUGHTON & SIMMS; diameter of circle, 30 inches; divided to 5′; read by reading microscopes to 1′, and micrometers to single seconds; aperture of objective, 4 inches; magnifying power ordinarily employed, 120 diameters.

(*c*) *Equatorial instruments:* Makers, ALVAN CLARK & SONS; aperture of objective, 9.25 inches; magnifying powers of eyepieces, 100 to 1,200, 20 in number.

(*d*) *Spectroscopes:* Large 9 prism CLARK spectroscope; seven prism, double acting (equivalent to 13 prisms), fitting equatorial mentioned above.

(*f*) *Chronographs:* BOND'S Spring Governor.

(*g*) *Clocks:* Mean time; makers, UTZSCHNEIDER & FRAUENHOFER, connected with chronograph; Sidereal, makers, UTZSCHNEIDER & MAHLER, of Munich, connected with chronograph.

(*i*) *Miscellaneous:* Comet seeker, aperture 3.6 inches, mounted on large tripod; small portable telescope, aperture 3 inches; zenith sector, loaned by Coast Survey, aperture 4 inches; full set of common meteorological apparatus, including a recording barometer; sextant by HARDY, of London.

III. OBSERVATIONS DURING THE PAST YEAR.

(*a*) For time and latitude.

(*d*) Class illustration on reversal of lines, and for prominences.

(*i*) Meteorological observations 3 times per day; sun spot observations since September 1, 1879.

IV. WORK PROPOSED FOR THE COMING YEAR: (1880.)

Similar work, with special attention to sun spots, prominence, &c., and spectroscopic observations.

Location of observatory: Hastings; (County) Westchester; (State) New York.

Name of observatory: Henry Draper's Observatory,
Longitude from Greenwich, 73° 52′ 25″ west.
Latitude, 40° 59′ 25″.

Authority for latitude and longitude: United States Coast Survey.

I. PERSONNEL:

Director, Dr. H. DRAPER.
Assistant, Mrs. DRAPER.

II. INSTRUMENTS:

(*b*) *Meridian transit instruments:* Makers, STACKPOLE BROS.; aperture, 2 inches; magnifying power, 25 diameters.

(*c*) *Equatorial instruments:* 28-inch silvered glass reflector by H. DRAPER; 12-inch achromatic by ALVAN CLARK.

(*d*) *Spectroscopes:* Grating spectroscope for solar work by ALVAN CLARK; stellar spectroscope by BROWNING; stellar photographic spectroscope by H. DRAPER; large spectroscope for research on oxygen in the Sun.

(*f*) *Chronograph:* by H. DRAPER.

(*h*) *Chronometers:* Mean time, makers, NEGUS BROTHERS; sidereal, makers, NEGUS BROTHERS, break circuit.

(*i*) *Miscellaneous:* Silvered glass altazimuth 15½ inches aperture;

petroleum engine; gramme machine; 17-inch induction coil; photographic apparatus.

III. OBSERVATIONS DURING THE PAST YEAR:

(*a*) The main work has been photography of the spectra of stars and the planets especially, and α Lyræ, Arcturus, Jupiter, and the Moon. The research on the presence of oxygen in the Sun has been continued.

IV. WORK PROPOSED FOR THE COMING YEAR: (1879–'80.)

Continuation of the above.

VI. ADDITIONAL INFORMATION:

The results of the researches in this observatory have been printed in the American Journal of Science, in the monthly notices of the Royal Astronomical Society, the Comptes Rendus of the French Academy of Science, and the Journal of the Italian Spectroscopists.

Location of observatory: (City) Haverford; (County) Montgomery; (State) Pennsylvania.

Name of observatory: HAVERFORD COLLEGE.

Longitude from Washington, ——.
Latitude, 40° 0′ 36″.5.

I. PERSONNEL:

Director, ISAAC SHARPLESS.

Assistants: 1. WILLIAM F. PERRY,
2. JOSIAH P. EDWARDS.

II. INSTRUMENTS:

(*a*) *Meridian circles:* 2; diameter of circles, 26 inches; divided to —′; read by 4 microscopes to 2″; aperture of objective, 4 inches.

(*b*) *Meridian transit instruments:* Aperture, 1½ inches.

(*c*) *Equatorial instruments:* Maker, FITZ; aperture of objective, 8¼ inches; magnifying powers of eyepieces, 60 to 900.

(*f*) *Chronographs:* BOND's magnetic.

(*g*) *Clocks:* Mean time; maker, WILLIAM E. HARPER, Philadelphia; 1 sidereal; makers, no name.

Prof. SAMUEL ALSOP, the previous director of the observatory, has been absent from duty during the past year on account of ill health.

Location of observatory: (City) Iowa City; (County) Johnson; (State) Iowa.

Name of observatory: C. W. Irish's Private Observatory.

Longitude from Washington, 57^{m} 52^{s}.
Latitude. 41° 39′$\frac{8}{10}$.

Authority for latitude and longitude: Observations by self during the past eleven years.

I. Personnel:

Director, C. W. Irish.
Assistants: 1. Mrs. C. W. Irish,
2. Miss Lizzie Irish,
3. Miss Ruth Irish,
4. Dr. C. M. Hobby.

II. Instruments:

(*b*) *Meridian transit instruments:* Makers, made by self; aperture, 1 inch; magnifying power, 11 diameters.

(*c*) *Equatorial instruments:* Makers, Chevalier, Paris; aperture of objective, 4 inches; magnifying powers of eyepieces, 25 to 300.

(*f*) *Chronographs:* A Morse register.

(*g*) *Clocks:* Mean time; makers, German make, beats ¾ seconds.

III. Observations during the past year:

(*a*) Have done nothing since the transit of Mercury, May, 1878.

(*Former*) *location of observatory:* (City) Jackson; (County) Jackson; (State) Michigan.

Longitude from Washington, west $29^{m}\ 29^{s}.74$.
Latitude, $42^{\circ}\ 14'\ 25''.21$.

Authority for latitude and longitude: Monument set by Lake Survey.

I. Personnel:

Director, O. Mulvey.

II. Instruments:

(*c*) *Equatorial instruments:* Makers, S. & B. Solomons, London; aperture of objective, 3 inches; magnifying powers of eyepieces, 30 to 205.

(*h*) *Chronometers:* Mean time; makers, Finer & Nowland, London.

III. Observations during the past year:

(*a*.) Telescope dismounted for past year. Will remount at Wichita, Kans.

VI. Additional information:

Having removed to Wichita, Kans., please address me at this place in future.

Location of observatory: (City) Lawrence; (County) Douglas; (State) Kansas.

Name of observatory: Connected with Kansas State University.

Longitude from Washington, $1^{h}\ 12^{m}\ 47^{s}.9$.
Latitude $38^{\circ}\ 57'\ 15''$.

Authority for latitude and longitude: Fred. W. Bardwell, late Professor of Astronomy, K. S. U.

I. PERSONNEL:

Director, H. S. S. SMITH.

II. INSTRUMENTS:

(*b*) *Meridian transit instruments:* Makers, STACKPOLE BROS.; aperture, 2¼ inches;

(*g*) *Clocks:* Mean time; makers, E. HOWARD & CO., Boston (medium); Sidereal; makers, BROCKBANKS, London (old).

(*h*) *Chronometers:* Sidereal; makers, T. S. & J. D. NEGUS, New York (good).

(*i*) *Miscellaneous:* Sextant, GAMBEY.

III. OBSERVATIONS DURING THE PAST YEAR:

(*b*) (*b′*) Time.

IV. WORK PROPOSED FOR THE COMING YEAR (1880):

Not settled.

VI. ADDITIONAL INFORMATION:

Observatory torn down in April. Small temporary observatory in process of construction.

Location of observatory: (City) Madison; (County) Jefferson; (State) Indiana.

Name of observatory: FAIRMOUNT OBSERVATORY.

Longitude from Washington, $0^h\ 33^m\ 34^s$ +.

I. PERSONNEL:

Director, ISRAEL FOWLER.

Assistant, My son.

II. INSTRUMENTS:

(*c*) *Equatorial instruments:* Maker, I. FOWLER; aperture of objective, 6 inches; magnifying powers of eyepieces, 90, 120, 300.

(*g*) *Clocks:* Mean time; maker, I. FOWLER.

(*i*) *Miscellaneous:* My yard is my observatory; location, Fairmount, near the City of Madison, Jefferson County, State of Indiana. I and my son are the observers. Instruments: 1. A 6-inch metal reflector, focal length 90 inches, mounted equatorially with hour and declination circles, also tangent screw for slow motion. 2. A portable silvered glass reflector 50 inches focal length, with eyepieces varying from 40 to 300 diameters. 3. A mean-time clock beats seconds, used as a regulator in my watch shop, all made by myself. I commenced my observations in 1869; scarcely a favorable night has passed without finding me at the telescope, but I have kept no record, so it can be of no service to science.

IV. WORK PROPOSED FOR THE COMING YEAR (1880):

I propose the coming year to keep a record of all observations made; so if I should awkwardly stumble upon something of interest I will communicate the same. My observations will be confined to sun spots, a search for Vulcan, and observing Jupiter and Saturn.

Location of observatory: Mount Lookout; (County) Hamilton; (State) Ohio.

Name of observatory: Cincinnati Observatory.

Longitude from Washington, 29^m 29.42^s W.
Latitude, 39° 8′ 35″.5.

Authority for latitude and longitude: American Ephemeris for 1880.

I. Personnel:

Director, Ormond Stone.

Assistant, Herbert A. Howe.

Student, H. V. Egbert.

II. Instruments:

(*b*) *Meridian transit instruments:* Makers, Buff and Berger; aperture, 3 inches; magnifying power, 100 diameters.

(*c*) *Equatorial instruments:* Makers, Utzschneider and Frauenhofer; finished by Merz & Mahler; object-glass refigured by Alvan Clark & Sons; aperture of objective, 11¼ inches; magnifying powers of eyepieces, 90 to 1,400.

(*c′*) Alvan Clark & Sons; aperture, 4 inches; magnifying powers, 15 to 250.

(*f*) *Chronographs:* Bond.

(*g*) *Clocks:* 2 mean time; makers, Robert Molyneux, Jas. Ritchie & Son.

(*h*) *Chronometers*, Sidereal, 1; makers, Wm. Bond & Son.

(*i*) *Miscellaneous:* Magnetic theodolite; maker, Gambey. Sextant; makers, Stackpole & Brother. Inclinometer, time-ball, telegraphic apparatus, etc.

III. Observations during the past year:

From September 1, 1878, to September 1, 1879.

(*b*) Determination of time and latitude.

(*c*) 2033 sets of double-star measurements.

(*c* and *c′*) Examination of surface of Sun on 180 days. Spots seen on 40. (*c′*) was used with one inch aperture until the middle of February, 1879. Since that (*c*) most of the time with an aperture of 5 inches.

IV. Work proposed for the coming year (1879–80):

Continuation of observations of double stars and observations of sun spots with (*c*); Durchmusterung south of 23° south declination with (*c*); determination of time with (*b*).

VI. Additional information:

Telegraphic time signals are sent to the city and a ball dropped from a staff at the observatory each day at noon.

Location of observatory: (City) Nashville; (County) Davidson; (State) Tennessee.

Longitude from Washington, 38^m, 56^s.
Latitude, + 36° 10′ 01″.

Authority for latitude and longitude: Mr. GEORGE DEAN, United States Coast Survey.

I. *Director*, E. E. BARNARD.

II. INSTRUMENTS:

(*c*) ***Equatorial instruments:*** Maker, JOHN BYRNE, New York; aperture of objective, 5 inches; magnifying powers of eyepieces, 52, 78, 85, 104, 173, 260, 330, 520. This instrument has simple equatorial mounting moved by hasp joint and handle (on tripod stand).

(*i*) ***Miscellaneous:*** Have also a small achromatic telescope with objective 2½ inches in diameter, simple vertical and horizontal mounting. I use a good silver watch and get my time from Western Union Telegraph office by noon signal from Washington.

(*c*) (*c′*) Jupiter, changes in belts, etc.

IV. WORK PROPOSED FOR THE COMING YEAR (1880):

I propose to use what time I can spare observing further the changes on Jupiter; and particularly the lunar crater Plato. Also other objects which come under my notice and time.

VI. ADDITIONAL INFORMATION:

The spare time from my work has been very little, and most of that has been occupied in the study of mathematics. What little time I have had for observing has been employed in the observation of the lunar crater Plato and the changes on the surface of the planet Jupiter; making drawings of his belts, etc. Since last season a large oblong *red* spot or short belt, rather,has appeared. I have been watching this to detect any changes that may occur in it. I have made drawings at every favorable opportunity of this remarkable spot, but I have so far been unable to detect any positive change in it, but there seems to be change going on in some of the belts, especially in the belt immediately above the *red* spot and nearer the equator of the planet. This seems to be changing in form and color. When I first noticed this belt it was of a dusky grayish tint; then, afterwards, of a beautiful bluish color; this bluish tint was quite marked. The northern of the equatorial belts is very ruddy, but heretofore has been not near so red as the large red spot, but on the night of the 14th of September it seemed to be fully as ruddy as the spot. My lack of proper instrumental equipment has kept me from making any very accurate observations. I would further state in regard to the changes of Jupiter that on the above-mentioned night, at 9^h 30^m, there were one or two little round spots on the disc near the South Pole; they appeared about the size of one of the satellites (the 3rd) which had come on the disc half hour or so before; they were faint and not seen readily. I had not noticed these spots before.

Location of observatory: (City) New Haven; (County) New Haven; (State) Connecticut.

Name of observatory: The SHEFFIELD SCIENTIFIC SCHOOL OF YALE COLLEGE.

Of equatorial { Longitude from Washington, $0^h\ 16^m\ 30^s.0$ E.
Latitude, 41° 18′ 36″.5 N.

Authority for latitude and longitude: Latitude from observations with zenith telescope by C. S. L. Longitude, Coast Survey. The Coast Survey latitude is 41° 18′ 40″.67.

I. PERSONNEL:

Director, C. S. LYMAN.
Assistant, WILLIAM BEEBE.

II. INSTRUMENTS:

(*a*) *Meridian circles:* Makers, ERTEL & SONS, 1845. Altered by WM. J. YOUNG, 1855, and regraduated 1876; diameter of circles, 40 inches; divided to 2′; read by six microscopes to 1″; aperture of objective, 3.8 inches; for observations of the Sun, aperture employed, 1.7 inches; magnifying power ordinarily employed, 190 diameters; focal length, 58.2 inches.

(*b*) *Meridian transit instruments:* Makers, one by C. S. L., of 36-inch focal length; aperture, 2.6 inches; magnifying power, 185 diameters. Circle, 12 inches, reading to 10″ by verniers. It has declination micrometer and fine level, for use as zenith telescope, made in 1852–'53.

(*c*) *Equatorial instruments:* Makers, ALVAN CLARK & SONS; aperture of objective, 9 inches; magnifying powers of eyepieces, 40, 80, 140, 200, 280, 450, 620.

(*c*′) Portable $4\frac{3}{8}$-inch refractor by Messrs. CLARK & SONS.

(*d*) *Spectroscopes:* By A. CLARK & SONS, of 7 prisms twice traversed.

(*f*) *Chronographs:* One just finished by A. CLARK & SONS.

(*g*) *Clocks:* Sidereal; makers, 1 by APPLETON, London, and 1 by E. HOWARD & SONS, Boston.

(*h*) *Chronometers:* Sidereal; maker, POOLE, improved by NEGUS.

(*i*) *Miscellaneous:* 1 bi-filar position micrometer by DOLLOND; 1 multiple ring micrometer (8 rings); 1 patent sextant by PISTOR & MARTINS; 1 patent reflecting circle by PISTOR & MARTINS. Yale College has also a 10-foot refractor of 5-inch aperture by DOLLOND, and a 5-foot transit instrument of 4-inch aperture by TROUGHTON & SIMMS. The former is in charge of Professor LOOMIS, the latter not mounted.

III. OBSERVATIONS DURING THE PAST YEAR (from September, 1878, to September, 1879):

(*b*) (*b*′) Time observations for city and chronometers of the port. Practice of students for time, latitude, longitude, etc.

(*c*) (*c*′) Observations of BRORSEN'S and SWIFT'S comets, etc.

IV. WORK PROPOSED FOR THE COMING YEAR (September, 1879, to September, 1880):

Of Mars at opposition for parallax, comets, and occultations, &c.; meridian circle, for redetermination of latitude, &c.; the work of instruction leaves but limited opportunity for other work.

Location of observatory: (City) Newington; (County) Hartford; (State) Connecticut.

Name of observatory: PRIVATE OBSERVATORY of D. W. EDGECOMB.

Longitude from Washington, 5° 21′ 30″ E.

Latitude, 41° 44′ 0″.

Authority for latitude and longitude: Difference from Hartford Statehouse, Coast Survey.

I. PERSONNEL:

Director, D. W. Edgecomb.

Assistants, None.

II. INSTRUMENTS:

(*c*) *Equatorial instruments:* Makers, A. CLARK & SONS; aperture of objective, 9.4 inches; magnifying powers of eyepieces, various up to 2,000. (See general description.)

(*g*) *Clocks:* Mean time; Swiss regulator, seconds.

VI. ADDITIONAL INFORMATION:

This observatory consists of a small frame building, with dome 12 feet 6 inches diameter, upon the grounds of the owner, covering an equatorial telescope. The latter rests upon a granite pedestal, weighing about 1,500 pounds. The mounting is by YOUNG, of Philadelphia, and is of the best workmanship. The declination circle is 13 inches in diameter, reading by verniers to 10 seconds of arc. The hour circle is 10 inches diameter, reading by verniers to 4 seconds of time. The graduations are upon silver. The object-glass, tube, and finder are by A. CLARK & SONS. The aperture of the object-glass is 9.4 inches, with a focal length of 121 inches, and is without doubt the finest specimen of the skill of Mr. ALVAN CLARK. Under the most rigid tests, its figure is found to approach very closely to absolute perfection. It is shown also by the vision it gives of the closest double stars and the faintest companions to bright stars hitherto discovered. Among the former, γ^2 Andromedæ, λ Cassiopeæ, and η Coronæ in its present position (September, 1879) may be mentioned, and of the latter class, the companions to γ Lyræ, ζ Aquillæ, ϵ and ρ Hydræ, the star closely following the attendant to Regulus, and under very favorable circumstances the 2″ companion to ϵ Coronæ. The instrument has been used for general observations of the stars, moon, and planets, other occupations preventing the owner from carrying on at present any more regular work.

Location of observatory: (City) New York; (County) New York; (State) New York.

Name of observatory: Mr. RUTHERFURD'S PRIVATE OBSERVATORY.

Longitude from Washington, east 3° 3′ 52″.05.

Latitude north, 40° 43′ 48″.53 ± 31.

Authority for latitude and longitude: United States coast surveying party (1859), with zenith telescope upon 24 pairs of stars, and telegraphic communication with Washington and Cambridge.

I. PERSONNEL:

Director, L. M. RUTHERFURD.

Assistant, D. C. CHAPMAN.

II. INSTRUMENTS:

(*b*) *Meridian transit instruments:* Maker, STACKPOLE; aperture, 3 inches.

Only used for time.

(*c*) *Equatorial instruments:* Makers, Messrs. RUTHERFURD & FITZ, aperture of objective, 13 inches.

(*c′*) The telescope has been employed mostly in photographing the sun, moon, and groups of stars.

(*f*) *Chronographs:* MORSE.

(*g*) *Clocks:* Sidereal; Maker, DENT.

Location of observatory: (City) Northfield; (County) Rice; (State) Minnesota.

Name of observatory: OBSERVATORY of CARLETON COLLEGE.

Longitude from Washington, 93° 9′ 14″ approximately.

Latitude 44° 27′ 41″ approximately.

Longitude: Occultation of Jupiter's satellites. We hope soon to be determined telegraphically.

Authority for latitude and longitude: Observations with telescope taking a great number of measures of pairs of stars with micrometer according to Coast Survey practice.

I. PERSONNEL:

Acting Director, WILLIAM W. PAYNE.

Assistants: 1. A. C. WILSON.
2. W. T. BILL.

II. INSTRUMENTS:

(*b*) *Meridian transit instruments:* Makers, FAUTH & CO., Washington; aperture, 3 inches; magnifying power, 60, 70, and 80 diameters.

(*c*) *Equatorial instruments:* Makers, A. CLARK & SONS, Cambridgeport, Mass.; aperture of objective, 8¼ inches; magnifying powers of eye-pieces, 50, 100, 200, 400, 800, besides a series of micrometer powers.

(*c′*) Portable equatorial: Makers, JOHN BYRNE, New York; objective, 4.3 inches clear aperture.

(*f*) *Chronograph:* An electro-magnetic instrument by A. CLARK & SONS.

(*g*) *Clocks:* 1 mean time; makers, E. HOWARD & CO., Boston; 1 sidereal; makers, E. HOWARD & CO., Boston.

(*h*) *Chronometers:* 1 sidereal; makers, W. BOND & SON, Boston.

(*i*) *Miscellaneous:* A partial outfit of metereological instruments.

III. OBSERVATIONS FOR THE PAST YEAR:

Instruments just received. No regular work in observatory yet undertaken, except the completion of a trial orbit for comet I of 1879.

IV. WORK PROPOSED FOR THE COMING YEAR (1879-'80):

1. A series of double-star measures, to determine personal equation.
2. Observations on comets II and III, for 1879.
3. Observations of the planet Jupiter, respecting the color of disc.
4. Miscellaneous work, to aid State Astronomical Society; there being no other instrument equal to our equatorial in the State.

VI. ADDITIONAL INFORMATION:

One year ago our clocks were set and regulated; since that time we have had control of the time in this entire State, and parts also of Iowa, Nebraska, Kansas, Dakota, and Missouri. When full connections are made, our noonday signal is directly distributed over 1,285 miles of wire, thereby supplying each telegraphic station in all this wide area with the daily time of our meridian. All the railroads (I believe) and the principal cities adopt our time.

[Extracts from previously-published information.]

"CARLETON COLLEGE.—PLAN OF INSTRUCTION AND ORIGINAL WORK.

The main building of the new observatory is now completed, and is 20 feet square and 32 feet high. There are two wings, each 12 by 15 feet and 9 feet high, with flat roof. The east wing is for the astronomical library and the observer's study. The west wing is used for the transit room only. On the first floor of the main building is the instrument case, table for chronograph, pier for astronomical clocks, and circular stairway leading to the equatorial room in the dome.

The central equatorial pier starts 9½ feet below the ground, has a footing of large flat stone, is built circular, with a diameter 8 feet, and is laid of solid masonry in cement to a height of 5 feet above the ground. From the footing it is curbed with dry stone way to the surface of the ground, that it may stand independent. Above it is built of brick in circular form to the upper surface of the second floor, and capped with a stone 3½ feet in diameter and 8 inches thick. The entire height of the pier is 26 feet. The pier for the transit instrument is made in a similar manner, except that it is rectangular in shape.

The second story of the building is devoted to the equatorial room, which is circular, and 16 feet in diameter inside. It is also a little more than 16 feet from the floor to the highest point of the dome. The dome is a hemisphere, and rests on twelve sheaved rollers, and is revolved by machinery at the pleasure of the observer.

The transit is already received. It was made by Messrs. Fauth & Co., of Washington, at a catalogue price of $900. Its telescope has 3 inches clear aperture and 3½ feet focal length. It has a striding level reading to seconds of arc, a 6-inch setting circle with level alidade on axis divided on silver and reading to thirty seconds, glass micrometer instead of spider lines, illumination on the new plan through the axis with side reflector, so as not to interfere with the object rays. The clamp is of the improved Davidson form. One of the Y's can be moved in azimuth and the other in altitude. The transit is also provided with a neat and convenient reviewing apparatus that will add much to facility in work. Before the instrument was shipped from Washington it was tested by Professor Hilgard, one of the leading officers of the Coast Survey, who acted as chairman of the committee of judges on astronomical instruments at the late Centennial Exposition. He pronounces the transit excellent in design and finish.

The observatory will be provided with two clocks, a sidereal and a mean time, costing about $500 each. The former is already in place and nearly regulated. The latter is expected daily.

A 4-inch equatorial portable instrument has been ordered, at a cost of about $400. Correspondence is now being had respecting the purchase and making of a large 8½-inch equatorial instrument. It is to be mounted in the best style, and to be provided with a driving clock. It cannot be completed in less than six months, and therefore may not be received until late this fall. It is, however, hoped that it may be secured and set ready for use this coming winter. Its cost will not vary much from $3,000.

CARLETON COLLEGE TIME SIGNALS.

Few of those who have visited the observatory of Carleton College, in our city, have definite knowledge of the system of daily time signals which are given from it. Very little has been written or published respecting the details of regulating the time by astronomical observations, or of the noon-day distribution of it over the vast area of portions of six different contiguous States.

It is not our purpose now to describe either branch of this practical or useful work to which the instruments of the observatory have been mainly devoted for the five months since it was erected, but rather to mention a few facts respecting the time signals that have been noticed by friends of the institution who have asked for a brief statement of them for publication.

The observatory is connected with the main line of the Northwestern Telegraph Company, and hence may use, at pleasure, either the commercial or the railroad line for communication with any distant points. By courtesy of the officers of the telegraph company our branch line was erected and a complete set of instruments supplied for the observatory office.

The mean-time regulator of the observatory, by great care, is kept accurately in true time. To be assured of this frequent time star-observations are taken by which the error and rate of the sidereal regulator are known. The mean-time is deduced from this, and any needed correction of the mean-time clock is made by an ingenious magnetic attachment which is controlled by an electric current at the pleasure of the person in charge.

Daily, at three minutes before noon, the mean-time clock, which is provided with an electrical attachment, is connected with the telegraph lines of the Chicago, Milwaukee and Saint Paul Railroad, and from this line to the Saint Paul and Sioux City Railroad, and nearly all others in the State and some out of it. The clock is so constructed that it will give its own signal so as to be understood at the most distant points where line-connections are made. As an example of the facility and extent of the daily time signals which the observatory regulator furishes, we will quote from a letter recently received from our friend, W. H. Drake, of Saint Paul, train-dispatcher of the Saint Paul and Sioux Railroad:

> Monday, 17th, your clock beat time for 1,285 miles of line wire through (near as I can count it) 157 instruments. Where the Milwaukee and Saint Paul line via Mason City crosses our line at Sheldon, Iowa, our instruments are on the same table. The stroke of the clock comes to each of them alike. Monday, Kansas City was the terminus. The stroke sounded in Minnesota, Iowa, Dakota, Nebraska, Kansas, and Missouri. When I can arrange with the Union Pacific for some fair day we will try to compare time with the Pacific coast. They have been ready twice, but did not give sufficient time to arrange with you.

This single incident will serve to show the wide sphere of usefulness and of influence which the college has and may hold if it can carry out plans of work already well begun."—(*Rice County Journal.*)

Location of observatory: (Near) Oxford; (County) Lafayette; (State) Mississippi.

Name of observatory: UNIVERSITY OF MISSISSIPPI.

Longitude from Washington, W. $0^h\ 49^m\ 55^s.03$.
Latitude N. 34° 22′ 12″.64.

Authority for latitude and longitude: R. B. FULTON.

I. PERSONNEL:

Director, R. B. FULTON.

II. INSTRUMENTS:

(*a*) *Altitude-azimuth:* Makers, LEREBOURS & SECRETAN; diameter of circles, 10 inches; divided to 10′; read by 4 microscopes to 10″; aperture of objective, 1½ inches.

(*b*) *Meridian transit instruments:* Makers, B. PIKE & SONS; aperture, 2¼ inches.

(*c*) *Equatorial instruments:* Maker, MERZ, of Munich; aperture of objective, 4½ inches; magnifying powers of eye-pieces, 96 to 312 diameters.

(*d*) *Spectroscopes:* 1 KIRCHHOFF'S 4-prism table spectroscope.

(*g*) *Clocks:* 1 mean time; makers, RITCHIE & SONS, Boston.

(*h*) *Chronometers:* 1 sidereal; makers, WM. BOND & SON, Boston.

III. OBSERVATIONS DURING THE PAST YEAR:

From January 1, 1878 to July 1, 1879.

(*a*) Determination of latitude.

(*b*) Determination of local time.

(*c*) Transit of Mercury, May, 1878.

(*h*) Local time and transit of Mercury.

VI. ADDITIONAL INFORMATION:

Transit of Mercury duly observed and report transmitted to Naval Observatory and published in Appendix II to Washington Observations for 1876.

Location of observatory: (City) Phelps; (County) Ontario; (State) New York.

Name of observatory: RED HOUSE OBSERVATORY. (Private.)

Longitude from Washington: Recent surveys make it very close to the Washington meridian.

Latitude, 42° 58′.

I. PERSONNEL:

Director, WM. ROBT. BROOKS.

Assistant, Mrs. MARY E. BROOKS.

II. INSTRUMENTS:

(*i*) *Miscellaneous:* Instruments used are a 2-inch refractor, 36 inches focal length, mounted as altitude-azimuth; magnifying powers 30, 45, 100 diameters; objective imported; mounted by the observer. A 5-inch aperture silver-on-glass Newtonian reflector, 50 inches focal length, altitude-azimuth mounting; magnifying powers, 40, 60, 140 diameters; made by the observer.

III. OBSERVATIONS DURING THE PAST YEAR:

From September 1, 1878, to September 1, 1879.

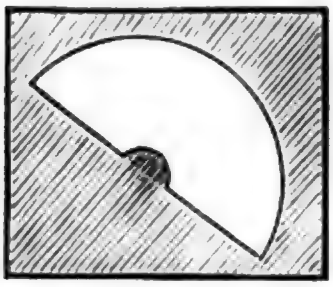
My observations have been mainly of sun-spots, planetary phenomena, and comet-seeking, using both instruments, but chiefly the reflector for sun-spots and comet-seeking. Have made several observations of SWIFT'S comet (No. 1 of 1879); PALISA'S (No. 2); and HARTWIG'S (No. 3) has been seen by glimpses.

IV. WORK PROPOSED FOR THE COMING YEAR (1879–80):

A continuation of the work of the past year is intended for the coming year, especially that of sun-spots with the 5-inch reflector, and watching for the transits of inter-mercurial planets, and also comet-seeking and locating new nebulae. To the better fitting of myself for comet-seeking I propose to construct, the coming winter, a new reflector of 10 or 12 inches aperture and short focal length.

VI. ADDITIONAL INFORMATION:

Several descriptive articles of the new comets of SWIFT and PALISA, planetary phenomena, and sun-spots, in the daily press (principally Rochester, N. Y., Democrat and Chronicle), the Phelps Citizen (weekly), and the Scientific American.



Last September, while observing Mercury one morning at the time of its conjunction with Venus, I observed a dark semicircular notch out of the illuminated portion of Mercury, near the middle of the terminator, report of which was sent to the Naval Observatory. It occurred to me as having a connection with the *bright* spot seen on Mercury at the time of its last transit (seen independently by myself as well as many others), and as confirming PROCTOR'S notion of a hole through Mercury.

Location of observatory: (City) Providence; (County) Providence; (State) Rhode Island.

Name of observatory: SEAGRAVE OBSERVATORY.

Longitude from Washington, E. $0^h\ 22^m\ 34^s.51$.

Latitude, $41^\circ\ 49'\ 46''.4$.

Authority for latitude and longitude: United States Coast Survey and ourselves.

I. OBSERVERS:

F. E. SEAGRAVE and LEONARD WALDO.

II. INSTRUMENTS:

(*c*) *Equatorial instruments:* Makers, ALVAN CLARK & SONS; aperture of objective, 8 inches; magnifying powers of eyepieces, 1, 122; 2, 245; 3, 367; 4, 489; 5, 611.

(*d*) *Spectroscopes:* 1 spectroscope having a system of four whole and two half prisms of 60° flint glass, which gives a dispersive power of ten prisms, by reflection.

(*g*) *Clocks:* 1 sidereal.

(*h*) *Chronometers:* 1 sidereal; maker, VICTOR KULLBERG, London.

III. OBSERVATIONS DURING THE PAST YEAR:

From August 1, 1878, to August 1, 1879.

(*a*) Observations of θ Cassiopeæ to investigate its large proper motion, and if possible to determine its parallax.

(*c*) (*c'*) Observations of the satellites of Saturn.

(*d*) Observations of a few double stars discovered by S. W. BURNHAM, Esq., of Chicago.

Location of observatory: (City) Rochester; (County) Monroe; (State) New York.

Name of observatory: "WARNER OBSERVATORY."

Longitude from Greenwich, 77° 51′.
Latitude, 43° 8′ 17″.

Authority for latitude and longitude: Signal Service officer.

I. PERSONNEL:

Director, LEWIS SWIFT.

II. INSTRUMENTS:

(*c*) *Equatorial instruments:* Makers, ALVAN CLARK & SONS (constructing) aperture of objective, 16 inches; magnifying powers of eyepieces, from 45 to 2,000.

(*c′*) Altitude azimuth 4½ inches, by FITZ; powers from 25 to 432.

III. OBSERVATIONS DURING THE PAST YEAR:

(*c′*) Almost exclusively in charting nebulæ and searching for comets. Comets I (SWIFT'S), II (PALISA'S), and III (HARTWIG'S) were severally observed. Several nebulæ heretofore overlooked have been found and recorded. The "brick-red" spot on Jupiter and changes in the color of his belts have been observed.

IV. WORK PROPOSED FOR THE COMING YEAR (1880):

With 16-inch equatorial, when mounted (about July 1), discovering, observing, and cataloguing nebulæ on moonless nights, and on double-star work when moon interferes with nebular work. The solar disk will receive a share of my attention with a view to detect the transits of intra-mercurial planets. With 4½-inch, comet-seeking as heretofore.

VI. ADDITIONAL INFORMATION:

During the year I have discovered one new comet (Comet I, 1879), viz: on the morning of June 17, civil time, with elements unlike any heretofore recorded. At the time of discovery I suspected its cometary character, but soon clouding up I was unable to decide it until the morning of the 21st. Immediate notification was given to Professor BAIRD, who caused its discovery and its position to be cabled to Europe. The customary notifications were also given to astronomers in this country. It was a faint comet during the whole period of its visibility. I several times lost and recovered it, and by determined effort was able to observe it as late as September 17–18, after which I was unable to follow it.

Location of observatory: (City) Saint Louis; (County) Saint Louis; (State) Missouri.

Name of observatory: WASHINGTON UNIVERSITY OBSERVATORY.
Longitude from Washington, W. $0^h\ 52^m\ 37^s.02$.
Latitude, N. 38° 38′ 3″.64.

Authority for latitude and longitude: A pier about 150 feet away from the observatory pier was located by HARKNESS and EIMBECK (1870). A survey was made by me from that pier to the new one.

I. PERSONNEL:

Director, J. K. REES.

Assistant, E. A. ENGLER.

II. INSTRUMENTS:

(*b*) *Meridian transit instruments:* Maker, WÜRDEMANN; aperture, 2.65 inches; magnifying power, 90 diameters, with micrometer attachment.

(*c*) *Equatorial instruments:* Maker, H. FITZ, of New York City; aperture of objective, 6¼ inches; magnifying powers of eyepieces, 76, 125, 190, 305, and 456 diameters.

(*c′*) *Finder:* $2\frac{3}{100}$ inches aperture; magnifying power, 23 diameters.

(*d*) *Spectroscopes:* One single prism BROWNING spectroscope.

(*e*) *Photometers and other subsidiary apparatus:* Filar position, micrometer attached; clock work for moving telescope.

(*g*) *Clocks:* Mean time; common tower clock.

(*h*) *Chronometers:* Mean time; makers, (1) DENT No. 2749, (2) BLACKIE No. 789.

(*i*) *Miscellaneous:* Sextant, by BLUNT, of New York City.

III. OBSERVATIONS DURING THE PAST YEAR:

(*b*) Observations of time stars. We furnish the time to 30 different points in the city. These points are connected by wire with our tower clock. Senior class study appearance of planets, Sun, and Moon. Some double stars measured.

(*i*) Used in class instruction and when the transit cannot be employed.

IV. WORK PROPOSED FOR THE COMING YEAR (1879-80):

(1) To continue the time service and to extend it.

(2) Measurements of double stars.

VI. ADDITIONAL INFORMATION:

The only papers which we have published are:

(1) Outlines of work done by the Fort Worth solar eclipse party. (Proceedings A. A. A. S., 1879.)

(2) Report of personal work at Fort Worth in vol. "Report of the observations of the total solar eclipse July 29, 1878, made at Fort Worth, Texas, 1879."

Location of observatory: (City) San Francisco; (County) San Francisco; (State) California.

Name of observatory: LICK ASTRONOMICAL DEPARTMENT OF THE UNIVERSITY OF CALIFORNIA.

VI. ADDITIONAL INFORMATION:

The "additional information" comprises the whole of what I am able to report concerning the "Lick Astronomical Observatory."

During this summer temporary accommodations have been erected at Mount Hamilton (observatory site), Santa Clara County, California, including a snug little house with revolving dome and masonry pier, upon which Prof. S. W. BURNHAM has a 6-inch equatorial mounted and at work with clock, micrometer, etc.

Professor BURNHAM is making various experiments to test the capabilities of the position as a place of observation, and his report will no doubt be received with eager interest.

The preliminary steps above indicated comprise the work of practical advancement so far as accomplished during the past year, being, it is hoped, a commencement of more effective progress.

Location of observatory: (City) South Bethlehem; (County) Northampton; (State) Pennsylvania.

Name of observatory: SAYRE OBSERVATORY.

Longitude from Washington, 6^{m} $40^{s}.19$ east.

Latitude, 40° 36′ 23″.89 ± .036.

Authority for latitude and longitude: For longitude, Appendix I, Washington Observations 1875. Latitude, Ast. Nach., No. 2260.

I. PERSONNEL:

Director, C. L. DOOLITTLE.

II. INSTRUMENTS:

(*a*) *Meridian circles:* None.

(*c*) *Equatorial instruments:* Makers, CLARK & SONS; aperture of objective, 6 inches; magnifying powers of eyepieces, 12 to 225.

(*g*) *Clocks:* Sidereal; makers, BOND & SON.

(*i*) *Miscellaneous:* A portable transit instrument by STACKPOLE, a zenith telescope by BLUNT, and a prismatic sextant by PISTOR & MARTIN.

III. OBSERVATIONS DURING THE PAST YEAR:

(*a*) The field instruments are designed for the use of students in astronomy of the university, and have been employed to good purpose by them

(*c*) (*c′*) With the equatorial a series of measurements of Jupiter's satellites has been made; also a considerable number of eclipses and other phenomena of those satellites. A few observations of BRORSON'S comet were also made.

IV. WORK PROPOSED FOR THE COMING YEAR (1879–'80):

The observations of Jupiter will be continued, and such attention given to comets, eclipses, or other special appearances as circumstances will permit.

V. PRINCIPAL PUBLICATIONS OF THE OBSERVATORY DURING THE YEAR 1879:

1. C. L. DOOLITTLE, Observations of Jupiter's Satellites, published in Ast. Nach.

2. C. L. DOOLITTLE, Mean declinations and proper motions of 58 stars, and the latitude of the Sayre Observatory, in Ast. Nach., vol. 95, page 49.

Location: Tarrytown, Westchester County, New York.

Position: Latitude, 41° 04′ 21″ north; longitude, 73° 51′ 14″ west, Greenwich.

Authority: United States Coast Survey.

The instrumental outfit under my control is so meager and unimportant as not to warrant an entry under the headings given above.

The principal work done during the past year has been in connection with the observations taken at Central City, Colo., at the time of the solar eclipse of 28th July, 1878. As a member of the party in charge of Prof. E. S. HOLDEN, I determined the residuals between the times of observed contact and the instants obtained by computation from the lunar tables.

CHAS. H. ROCKWELL.

Location of observatory: (City) Poughkeepsie; (County) Dutchess; (State) New York.

Name of observatory: VASSAR COLLEGE.

Longitude from Washington, 12^m, $38^s.5$.
Latitude 41° 41′ 18″.

I. PERSONNEL:

Director, MARIA MITCHELL.

II. INSTRUMENTS:

(*a*) *Meridian circles:* 1; maker, YOUNG, of Philadelphia; aperture of objective, 3¾ inches.

(*c*) *Equatorial instruments:* Makers, object glass by CLARK; aperture of objective, 12¼ inches; magnifying powers of eyepieces, 200 to 600+.

(*f*) *Chronographs:* One.

(*g*) *Clocks:* One clock sidereal; makers, Bond & Son.

(*h*) *One chronometer:* Mean time; makers, Bliss & Creighton.

(*i*) *Miscellaneous:* Small telescopes; one by CLARK & SONS; aperture, 3 inches.

III. OBSERVATIONS DURING THE PAST YEAR:

(*a*) Observations for time.

(*c′*) Observations on planets, especially Saturn.

(*i*) Observations on Sun spots.

IV. WORK PROPOSED FOR THE COMING YEAR (18—):

The work proposed for the coming year is the same as given above.

V. PRINCIPAL PUBLICATIONS OF THE OBSERVATORY DURING THE YEAR :

1. Maria Mitchell: Observations on the Satellites of Saturn; published in American Journal of Arts and Sciences, vol. xvii, June, 1879.

Location of Observatory: (City) Troy; (County) Rensselaer; (State) New York.

Name of Observatory: WILLIAMS PROUDFIT OBSERVATORY.

Longitude from Washington $13^m\ 27^s.5$ east (nearly).
Latitude 42° 43′ 52″.

Authority for latitude and longitude: Latitude determined by observations with the zenith telescope; longitude by signals from United States Naval Observatory.

I. PERSONNEL:

Director, Professor DASCOM GREENE.
Assistant, PALMER C. RICKETTS.

II. INSTRUMENTS:

(*b*) *Meridian transit instruments:* Makers, E. KÜBEL, Washington; aperture, 2.5 inches; magnifying power, 60 diameters.

(*b′*) Makers, PHELPS & GURLEY, Troy; aperture, 2 inches; magnifying power, 30 diameters.

(*c*) *Equatorial instruments:* Maker, HENRY FITZ, New York; aperture of objective, 3.5 inches; magnifying powers of eyepieces, 45 to 200 diameters.

(*g*) *Clocks:* Mean time; maker, STOKELL, New York; Howard, Boston.

(*h*) *Chronometers:* Sidereal; maker, J. FLETCHER, London.

(*i*) *Miscellaneous:* Sextant; TROUGHTON & SIMMS, London.

III. OBSERVATIONS DURING THE PAST YEAR:

From September, 1878, to September, 1879.

(*a*) Besides regular transit observations for time, by the director and assistant, the instruments have been used by the senior class of the Rensselaer Polytechnic Institute, for practice in astronomical observation.

IV. WORK PROPOSED FOR THE COMING YEAR (1879–'80).

This is expected to be similar to the work of the past year.

Location of observatory: (City) Washington, District of Columbia.

Name of observatory: UNITED STATES NAVAL OBSERVATORY.

Longitude from Greenwich $5^h\ 8^m\ 12^s.09$.
Latitude +38° 53′ 38.8″.

I. PERSONNEL:

Director: Rear-Admiral JOHN RODGERS, U. S. N.

Assistants:
1. Prof. A. HALL.
2. Prof. W. HARKNESS,
3. Prof. J. R. EASTMAN,
4. Prof. E. S. HOLDEN,
5. Prof. E. FRISBY,

} *Professors U. S. Navy.*

6. Mr. A. R. SKINNER,
7. Mr. H. W. PAUL,
8. Mr. H. S. PRITCHETT,

} *Permanent Assistant Astronomers.*

9. Mr. J. A. ROGERS,
Temporarily employed in photographic experiments.
10. Mr. W. F. GARDNER,
Instrument-maker.

II. INSTRUMENTS:

(*a*) *Meridian circles:* 1; makers, PISTOR & MARTINS; diameter of circles, 43.40 inches; divided to 2′; read by 4 microscopes to 0″.1; aperture of objective, 8.52 inches; for observations of the sun, aperture employed, 3 inches; magnifying power ordinarily employed, 186 diameters.

(*b*) *Meridian transit instruments:* Makers, ERTEL & SON, aperture 5.33 inches; magnifying powers 85, 86, 106, 118, 162.

(*b′*) Eight portable transits and zenith telescopes combined, used on Transit of Venus Expeditions.

(*c*) *Equatorial instruments:* Makers; ALVAN CLARK & SONS; aperture of objective, 26 inches; magnifying powers of eyepieces, 126 to 1600.

(*c′*) Made by MERZ: 9.62 inches aperture; powers, 90–900.

(*c″*) Eight 5-inch equatorials by ALVAN CLARK & SONS, used on Transit of Venus Expeditions.

(*e*) *Photometers:* One nebula-photometer (Hastings' pattern) for use with the 26-inch equatorial.

(*f*) *Chronographs:* Some 10 or 12 in all, of various kinds.

(*g*) *Clocks:* Mean time, 2; sidereal, 6.

(*h*) *Chronometers:* Mean time, all the chronometers of the United States Navy are kept here. Sidereal, eight, by NEGUS.

III. OBSERVATIONS DURING THE PAST YEAR:

(*a*) American ephemeris and miscellaneous stars; south stars of the B. A. C., many asteroids, and the Sun, Moon, and planets.

(*b*) The transit and mural and prime vertical transit are now out of use.

(*c*) Double stars, satellites of Mars, Saturn, Neptune, and Uranus, and nebulæ.

(*c′*) Occultations; and the finding of asteroids preparatory to their observation by the transit circle.

(*i*) A series of daily photographs of the sun and photographic experiments looking to eclipse-photography.

IV. WORK PROPOSED FOR THE COMING YEAR (1879-'80):

The same as in former years.

V. PRINCIPAL PUBLICATIONS OF THE OBSERVATORY:

Report on the Transit of Mercury, 1878.
EASTMAN, Meteorological Observations, 1876.
EASTMAN, Meteorological Observations, 1877.

VI. ADDITIONAL INFORMATION:

[The following is a short abstract of the annual report of the Superintendent of the Observatory to the Chief of the Bureau of Navigation, and in it will be found details additional to the information presented above.—E. S. H.]

UNITED STATES NAVAL OBSERVATORY,
Washington, October 20, 1879.

* * * * * * *

"I strongly recommend the removal of the institution to a better site. The present grounds are malarious, the river fogs obscure the vision, rendering it less clear than in a position more removed from the water. When the contemplated improvements are made on the river front, which seem only the question of a short time, when the marsh, partly encircling the observatory, is filled in, and the hill on which the buildings rest is used as a top-dressing to the land thus acquired, this part of the city will be the center of its water commerce, and its value to the government will be greater than the cost of a new situation for the observatory. It thus seems that when the hill is cut down the selection of a new site will be imperative. It will be better to select this new site now, for the cost will be greater in the future."*

THE 26-INCH EQUATORIAL.

The observers on this instrument have been the same as in the preceding year, namely, Prof. ASAPH HALL, in charge, and Prof. EDWARD S. HOLDEN, assistant. This instrument is now in good order, and is in constant use. The principal work done with it by the astronomers during the year is as follows:

The satellites of Saturn were observed until December 24, 1878. We have now accumulated a large number of observations of the three outer satellites of Saturn; and these observations ought to be completely reduced and discussed for the purpose of determining more accurately the orbits of these satellites and the mass of the planet.

The principal series of observations with this instrument are the observations of double stars by Professor HALL. The thirty stars selected by STRUVE for the comparison of micrometrical measurements by various observers have each been observed eight nights on an average. This work may now be considered as finished.

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*NOTE.—An appropriation of $75,000 has been made to purchase a new site.

In August last the Naval Observatory was honored by a visit from the distinguished director of the Pulkowa Observatory, Mr. OTTO VON STRUVE, and his son Mr. HERMANN STRUVE, who came for the purpose of examining our large telescope, with the view of purchasing a still larger one for the Imperial Observatory at Pulkowa. I am happy to say that the performance of our telescope was found satisfactory by so competent and experienced a judge, and that Mr. STRUVE has ordered a 30-inch objective from Messrs. ALVAN CLARK & SONS, the makers of our instrument.

THE TRANSIT CIRCLE.

This instrument, under the direction of Prof. J. R. EASTMAN, assisted by Prof. EDGAR FRISBY, and assistant astronomers A. N. SKINNER, H. M. PAUL, and H. S. PRITCHETT, has been employed in observations of—

(1.) Stars of the American ephemeris, for clock and instrumental corrections.

(2.) Sun, moon, major and minor planets.

(3.) Stars whose occultations were observed in connection with observations of the Transit of Venus in 1874.

(4.) Standard stars for a catalogue of zone observations.

(5.) Stars of the British Association Catalogue between 120° 0′ and 131° 10′ N. P. D.

(6.) Stars used in observations of comets with the 26-inch and 9.6-inch equatorials.

(7.) Stars used in the determination of latitude by the United States Coast and Geodetic Survey, the Lake Survey, Capt. G. M. WHEELER'S survey, and by Lieut. Commander F. M. GREEN in surveys in the West Indies.

(8.) Stars used by Mr. DAVID GILL, of the Royal Astronomical Society of London, in determining the solar parallax from observations of Mars with the heliometer.

The whole number of observations made with the transit circle since the last annual report is 4,100. Of these observations, 81 were of the sun; 61 of the moon; 130 of the major planets, and 146 of the minor planets.

The meteorological department is under the direction of Professor EASTMAN, and the usual observations, at intervals of *three hours*, have been made throughout the year.

The Observatory is responsible for the control, by means of the motor clock, of clocks in the State, War, Navy, and Treasury Departments; for furnishing accurate time-signals to the Western Union Telegraph Company, and for dropping the time-ball on the Western Union Telegraph Office in New York.

The facilities for controlling the clocks in the departments are now wholly inadequate; and a complete change will soon be made, which, it is hoped, will insure thorough and continuous control.

A change also in the method of transmitting time-signals and of dropping the Washington and New York time-balls is nearly completed, and will probably be in operation by the end of October.

PHOTO-HELIOGRAPHIC AND MISCELLANEOUS WORK.

Prof. WILLIAM HARKNESS reports as follows:

The photographs of the late Transit of Mercury were examined, and out of the whole number it was found that twenty-five of the Cambridge pictures, twenty-three of the Washington pictures, and sixty-four of the Ann Arbor pictures were sufficiently well defined for measurement. Accordingly, these one hundred and twelve plates have been read off, all but twelve being done in duplicate; and the computations, also in duplicate, have been nearly completed. About three months' work is yet required to determine from the photographs the final corrections to the right ascension and declination of Mercury.

The drawings of Mars, made by Professor HARKNESS during the opposition of 1877, have been transformed from the orthographic to Mercator's projection, and a map of the planet has been constructed. General tables have also been computed, which give directly the areographic latitude and longitude of the center of the disc of Mars, and the position angle of its axis as seen from the earth; the arguments being the geocentric right-ascension and north polar distance of the planet.

Mr. JOS. A. ROGERS has been employed under a special appropriation for experiments in astronomical photography, and has spent most of his time in endeavoring to overcome the uncertainties of the emulsion process. Here it may be well to remark that our success in photographing the total eclipse of the Sun of July, 1878, was largely due to the excellence of the emulsion which he furnished; and the future of astronomical photography seems to a great extent dependent upon the emulsion process. Hence the importance of the experiments in which Mr. ROGERS is engaged. He has also photographed the Sun on every clear day, and has made numerous copies of the negatives of the corona taken during the eclipse mentioned above.

THE LIBRARY.

The library is in charge of Prof. EDWARD S. HOLDEN, in addition to his other duties. It is now in a satisfactory condition.

A card catalogue has been begun, and over 9,000 cards made. Part I of the catalogue of the Library "Astronomical Bibliography" will be printed in 1879.

A complete index to the publications of the observatory, from 1845 to 1875, has been made. It will be printed as Appendix I to the Observations for 1876. At intervals of ten years similar indexes should be made.

The usual annual appropriation of $1,000 for the purchase and care of astronomical works should be continued.

In this connection it may be said that our library is now the best astronomical library in the United States, and is constantly appealed to by persons not connected with the observatory. It is highly desirable that it should be still further increased, and that this valuable collection, which, if destroyed, could hardly be replaced, should be safely lodged in a fire-proof room.

CHRONOMETERS.

There are at the present time in the chronometer room one hundred and ten (110) mean-time chronometers.

A time-ball on the tower of the Western Union Telegraph Company's main building in New York City is dropped daily at New York, noon (except Sunday), from the chronometer-room. During the year this ball has failed to drop eight times; three, because wires were out of order at New York; once, on account of the wire insulation here having been destroyed by lightning; three times, here, because of the mean-time clock having stopped, and the changing of wires while putting in instruments and telephones; and once, for which no cause could be found.

At Washington, noon, a time-ball is dropped from the staff on the dome of the observatory, and time-signals are transmitted to all parts of the United States.

The following paper by Prof. SIMON NEWCOMB, secretary of the Transit of Venus Commission, and charged with the preparation of the report, is herewith appended.

"The reductions of the Transit of Venus work are in the following state:

"Part I, containing a general discussion of the observations so far as to deduce equations of condition from them, is ready for the press.

"Part II, containing the reports of the observers and the observations made at the several stations, is also nearly ready.

"Part III, containing the discussion of the longitudes of the stations, from occultations, and other sources, is still incomplete and requires some examination from me, which I shall be unable to give it for two or three months to come.

"Part IV, which should contain the photographic plate-measures, is in the hands of Professor HARKNESS."

Location of observatory: Whitestone; (County) Queens; (State) New York.

Name of observatory: WILLETS POINT FIELD OBSERVATORY.

Longitude from Washington, east $13^{m}\ 04^{s}.57 \pm 0.14$.

Latitude, north $40^{\circ}\ 47'\ 20''$.

Authority for latitude and longitude: Observations with zenith telescope; telegraphic time signals from Washington.

I. PERSONNEL:

Director, General H. L. ABBOT, Corps of Engineers.

Assistants: Capt. A. M. MILLER, Corps of Engineers, and officers on duty with the battalion of engineers.

II. INSTRUMENTS:

(*b*) *Meridian transit instruments:* Maker, TROUGHTON; focal length, 30 inches; aperture, 2 inches; Russian transit, STACKPOLE & BRO.; focal length, 31 inches; aperture, 2½ inches; combined transit, and zenith telescope, WURDEMANN; focal length, 30 inches; aperture, 2½ inches.

(*c*) *Equatorial instruments:* Maker, TULLEY; portable; focal length, 65 inches; aperture of objective, 3.8 inches; magnifying powers of eyepieces, 50 to 200; mounted on tripod with SMEATON's block.

(*d*) *Spectroscopes:* 1; Chemical.

(*f*) *Chronographs:* Field pattern, made by NEGUS.

(*h*) *Chronometers:* Mean time; makers, ARNOLD & DENT (1). Sidereal; makers, BOND & SON (2); both with NEGUS break-circuit arrangement.

(*i*) *Miscellaneous:* 1. Zenith telescope, made by WÜRDEMANN, of latest pattern; magnifying power, 80 diameters; 2 STACKPOLE & BRO. sextants; 1 portable field transit, by STACKPOLE & BRO.; focal length, 24 inches; aperture, 2 inches.

III. OBSERVATIONS DURING THE PAST YEAR:

The object of the observatory is the instruction of junior officers of engineers on duty at the engineer school of application in practical field astronomy, such as they may be called upon to practice on boundary geodetic surveys. The work has been directed accordingly.

IV. WORK PROPOSED FOR THE COMING YEAR:

As above.

Location of observatory: (City) Ypsilanti; (County) Washtenaw; (State) Michigan.

Name of observatory: Michigan State Normal School.

Longitude from Washington, 6° 32′ 30″ west.
Latitude 42° 13′.

Authority for latitude and longitude: J. C. WATSON.

I. PERSONNEL:

Director, LEWIS MCLOUTH, M. A.

II. INSTRUMENTS:

(*b*) *Meridian transit instruments:* Maker, GURLEY, Albany; aperture, 1½ inches; magnifying power, 30 diameters.

(*c*) *Equatorial instruments;* Maker, A. CLARK, Cambridgeport, Mass; aperture of objective, 4 inches; magnifying powers of eyepieces, 45, 90, 144, 210.

(*d*) *Spectroscopes:* BROWNING, London, 2 prism.

(*h*) *Chronometers:* 1 Sidereal; maker, NEGUS.

(*i*) *Miscellaneous:* Our observatory building will be completed this fall. No systematic work has been done. Our building is small, and its equipment is for instruction rather than investigation. I expect, however, to have a larger and better outfit in the course of this school year. As my time is largely taken up with the work of instruction in physics and in chemistry as well as in astronomy, I cannot expect at present to do much. I hope within the year to get a much better transit instrument. My equatorial is quite good—the one with which Professor WATSON made his observations on the supposed planet Vulcan.

ABSTRACTS OF REPORTS OF EUROPEAN OBSERVATORIES.

[Translated and condensed from the Vierteljahrsschrift of the German Astronomical Society by GEO. H. BOEHMER, Smithsonian Institution.]

BASEL.

(ED. HAGENBACH, Director of the Physical Institute.)

The principal instruments are: The equatorial, made by the "Société Genevoise pour la construction d'instruments de physique" mounted on an isolated pillar, under a movable dome of 5 metres diameter. The instrument is provided with a centrifugal regulator, constructed according to Prof. M. Thury's directions, with position micrometer, spectroscope, and camera obscura.

The meridian circle, constructed by the Société Genevoise, with 2½ objective, by C. A. Steinheil.

The astronomical clock was constructed by Theodor Knoblich, in Hamburg.

The mean time is given by means of an electric pendulum, by M. Hipp, in Neuenburg.

Both clocks connect with a number of dials in various rooms, and also with the chronograph.

BERLIN.

(Prof. H. FOERSTER, Director of the Observatory; Dr. TIETJEN, Director of the Computing Bureau.

The small meridian circle was used by Dr. Steinbrink, a volunteer observer, in comparison star determinations for planetary observations.

The large meridian circle was used to continue the observations of the 521 fundamental stars of the V. J. S. Catalogue and those of Mayer's catalogue. In connection with this a series of observations were made which served partly to determine star positions for the examination of the heliometers of the German transit of Venus and Mr. Gill's expeditions, and partly to examine certain systematic errors in observing.

For time determinations and position of instrument 858 stars were observed on 108 nights.

Observations were made for examination of the influence of the position of the head (north or south) in observations of stars near the zenith. For the same purpose 155 observations of right ascension were made at the request of Mr. Gill on 12 stars designated by him.

The spare time was principally employed in determining the definite position of the (521) Bradley stars, and their mean positions turned over to Professor Auwers. The catalogue containing the (2,100) observations is to be published by the observatory.

Dr. Knorre observed with the 9-inch equatorial on determination of positions.

The new micrometer for the measurement and registration of differences of declination, described by Dr. Knorre in vol. 93 (p. 363) of the Astronomische Nachrichten, was brought into service in determination of 572 stars.

The time-service has been continued. The results of the service carried on jointly by the Berlin, Königsberg, and Hamburg observatories will probably be published shortly.

The principal work of the computing bureau has been, as in former years, the publication of the Astronomisches Jahrbuch.

Of the ephemerides of the 529 stars of the Astronomical Society the volume for 1879 was published; 22 circulars (83–104) were issued, and in them will be found 43 computations of new elements and 62 ephemerides. Of the former 33, and of the latter 47, were computed in Berlin. Of the "Correspondenzen über Planetenbeobachtungen," Nos. 46–68 were issued.

UNIVERSITY OBSERVATORY, BONN.

(Professor E. SCHÖNFELD, Director.)

The progress of the work has been greatly retarded by the unfavorable state of the weather and by a change in the personnel. Dr. Seeliger resigned, and his place was occupied by Dr. Deichmüller, who again was succeeded by Mr. Emil Kaiser.

The meridian circle was used in observing 53 zones and adding some important fragments, containing 380 stars of comparison and 1,707 zone stars. Six hundred and twenty-seven zones have been observed.

The southern review with the Schröder telescope, Mr. Kerper assisting, resulted in the determination of 44,204 star positions, which were partly reduced to 1855.

One hundred and two special catalogues were commenced and 46 completed.

A catalogue of doubtful observations has been commenced, containing now 780 numbers.

State of work December 31, 1878.

1. Zones: 395, 6 hours, containing 189,606 star observations.
2. Computation of reduction tables: no arrears.
3. Computed star positions: 3,000 in arrears.
4. Special catalogues of 1^h and 1° extension: Commenced, 439; arrears, 65; mostly finished, 100; complete, 160; without any doubt, 22.
5. Distribution of the observations.

Quadrant.	I.	II.	III.	IV.	Total.
	Hours.	*Hours.*	*Hours.*	*Hours.*	*Hours.*
Northern third	37.9	41.8	46.7	47.9	174.3
Middle	19.2	11.8	24.0	26.1	81.1
Southern third	27.5	29.7	38.0	45.0	140.2
Total	84.6	83.3	108.7	119.0	395.6

Observations on the light of variable stars were made, and the transit of Mercury observed on the 6th of May.

UNIVERSITY OBSERVATORY, BRESLAU.

(J. G. Galle, Director.)

Owing to a number of circumstances which prevented the purchase of new and improved instruments, the activity of the observatory, in an astronomical point of view, has been mainly confined to the instruction of the students of mathematics.

Regular observations, however, were made in meteorology, embracing a series of eighty-eight years (since 1791), to which were added, nine years ago, the daily records of the variation in the magnetic declination.

The works in progress are: A compilation and reduction of all the meteorological observations made at the observatory since 1791. This work also contains a compilation of geographical constants, topographical communications, and determinations of heights, and notes respecting the progress in astronomy in Silesia and elsewhere.

ROYAL OBSERVATORY, BRUSSELS.

(J. C. Houzeau, Director.)

The death of Mr. Ernest Quetelet has materially changed the programme of work of the observatory. Mr. Quetelet had, at the time of his death, commenced the last series of his work on stars with proper motion, an account of which work, commenced in 1848, was given by himself. Of the unfinished portion of the work the observations for 1876 are in the hands of the printer; the calculations of those for 1877 are well advanced, and the computation of those for 1878 will soon commence.

Meridian instruments were employed as follows: The mural circle to observe α and δ Ursæ minoris for the purpose of determining the latitude; the Gambey meridian transit to observe fundamental stars for time. Moon-culminating stars were observed for the determination of geographic longitudes. Telegraphic comparisons are being made with Greenwich.

The solar spectrum has been observed, and micrometric measurements made of certain double stars. The satellites of Jupiter were observed whenever the state of the sky permitted.

All the observations were made as accurate as the old instruments of the observatory permit, but it would be desirable to have them replaced by the new and improved ones now in course of construction.

PUBLICATIONS.—The "Annales de l'Observatoire" have been divided into 2 sections, the "Annales Astronomiques" and the "Annales Météorologiques." The first volume of "Annales Astronomiques" contains "Uranométrie Générale" and a compilation under the title, "Repertoire des Constants de l'Astronomie." The second volume contains the observations with the meridian instrument and with the mural circle, during the years 1873, 1874, 1875; physical observations of Mars during the opposition of 1877, accompanied by chromo-lithographed plates.

The first volume of the "Annales Météorologiques," about to appear, contains meteorological and magnetic observations made in 1876 and 1877.

"L'Annuaire" for 1879, and the catalogue of astronomical and meteorological books in the principal libraries of Belgium, have been published.

A law was passed on the 29th of March, 1877, directing the publication of a magnetic chart of the country. Observations for this purpose were taken on inclination, declination, and intensity, and the computations of the same are now in a well-advanced state.

DÜSSELDORF OBSERVATORY.

(Dr. ROBERT LUTHER, Director.)

The isolation and strength of the old brick pillar carrying the 7-foot instrument, weighing 975 pounds, having become doubtful, a new pillar of basalt lava, resting on a foundation of brick, laid in cement, was erected. A satisfactory proof of the stability of this new pillar has been offered in the recent severe shocks of earthquake, which did not change its isolation.

The fruitless searching for (118) Peitho and other not much observed planets, and the alarming increase (now about 38) in the number of minor planets observed in only one opposition, induces me to make the request that the observers may be assisted in future to overcome the difficulties of finding them again by more exact opposition-ephemerides and by the publication of several hundred special charts on the scale of the Paris charts.

In addition to the observations made for correction of instruments and time, 41 observations were made on 23 planets. Since 1847, 897 observations were made on 112 planets.

PRIVATE OBSERVATORY OF DR. EPSTEIN, FRANKFORT-ON-THE-MAIN.

The work of continuing Herschel's sweeps, undertaken in September, 1877, and reported upon last year, has been continued. In addition to the 219 fields, 264 fields were swept and 5,831 stars counted. The present state of the work is 483 fields and 13,500 stars. Observations were made on double stars and red stars. Saturn's satellites were observed on 24 nights from the 30th of August.

GOTHA OBSERVATORY.

(Dr. A. Krüger, Director.)

Since the last report the observations of the zone stars between 55° and 65° N. declination have been continued. Mr. A. Donner resigned his position as assistant, and was succeeded by Dr. L. de Ball. The number of zones has been increased to 643, and the observations now number 32,500. One or two nights will be sufficient to close the series. The computation of the observations was continued. The deduction of the transits and of the apparent declinations is nearly completed, as also tables of reductions to the mean positions for 1875. A copy was made for publication of the original observations. The original observations will be published at the earliest possible moment.

HAMBURG OBSERVATORY.

(Dr. Georg Ruemker, Director.)

Owing to prevailing unfavorable weather—only 181 nights during the entire year could be utilized, and in most cases only in part, for observing—the work of cataloguing stars and nebulæ progressed but very little. The meridian circle was employed in observations on time and on positions of fixed stars and planets. Positions of nebulæ were determined with the equatorial.

The usefulness of the IV Division of the "Seewarte" (chronometer-testing institute), which was placed under the observatory, has satisfactorily increased. On occasion of the second competitive chronometer test, instituted by the imperial navy department, 51 chronometers were exhibited by 12 German manufacturers, 7 of whom reside in Hamburg-Altona.

The time signals had to be discontinued for some time on account of the damage done to the apparatus during the severe storm of March 8. The time-ball stations at Cuxhaven and Bremerhaven have worked very satisfactorily.

Dr. G. Koch resigned his position, and was succeeded by Dr. Karl Schrader, of O'Gyalla, Hungary.

KREMSMÜNSTER OBSERVATORY.

(G. Strasser, Director.)

The meridian circle was furnished with new microscope and new horizontal level.

Observations on the Moon and moon-culminating stars were continued.

Planetary observations were made partly with the meridian instrument and partly with the refractor.

Uranus, Jupiter, and Neptune, were observed with the meridian circle.

Observations were made on 12 minor planets.

Fifty comparison stars of planets were determined with the meridian circle, for which purpose 160 positions had to be taken. A large number of positions of fixed stars were observed, but have not yet been reduced.

The transit of Mercury was invisible on account of clouds, and the same occurred on occasion of the eclipse of the Pleiades.

UNIVERSITY OBSERVATORY, LEIPZIG.

(Prof. C. BRUHNS, Director.)

No change has taken place in the personnel. The following gentlemen are volunteer observers: Messrs. Gautier, Dr. Hilfiker, von Dankelman, Keiser, Meier, Regler, Schneider, and Schnauder.

The following instruments were procured: A Meyerstein universal instrument, used by Dr. Börger in his expedition to East Greenland; a new registering apparatus by Fuess, including a polarizing relay. Telephonic connection has been established.

Mr. Weinek, who is still engaged in the discussion of the photographic views of Venus, observed with the meridian circle, and Dr. Peter, with the equatorial: 23 stars in RA and Decl. were observed, and 12 stars in RA for a discussion by Mr. Gill. Minor planets were observed with the meridian circle.

Preparations and experiments were made for zone-observations. Mr. Weinek observed the transit of Mercury with the 6-foot refractor, and took 44 photographic views of the planet by means of the photoheliograph, which was used, in 1874, in Kerguelen Island.

Dr. Peter, with the equatorial, made in 99 nights, 181 observations on 51 minor planets and 12 observations on comparison stars.

Tempel's comet was invisible, and observations on Swift's comet failed on account of an error in the dispatch announcing the discovery.

The first contact in the transit of Mercury, an eclipse of the Moon, and eclipses of the satellites of Jupiter, were observed.

The changes supposed by Dr. Klein to have taken place in Hyginus in the Moon, failed to be detected in drawings made by Dr. Peter for the purpose.

Mr. Leppig, with a small Frauenhofer refractor, observed on sun-spots; he also observed the transit of Mercury, the eclipse of the Moon, etc.

Mr. Schneider practiced with the 6-foot refractor and made drawings of nebulæ. Mr. Dietrich examined the photometer, but did not complete a series of observations.

The first volume of the "Leipzig Beobachtungen" will be published shortly.

METEOROLOGICAL WORK.—The greater part of the observations with self-registering instruments were reduced by Mr. Leppig. The results of the tri-daily observations were published in the annual report of the Leipzig Geographical Society. The volume containing the tri-daily observations of all stations will be published shortly. Telegraphic observations were sent to General Myer, in Washington. Mr. von Dankelman is in charge of the Bureau for Weather Prognostics.

MISCELLANEOUS.—Mr. Weinek, assisted by Mr. Regler, and Dr. Hilfiker, has continued the reductions of the transit of Venus.

Mr. Harzer's time and geographical determinations of the Venus expedition, were revised by Mr. Schneider, and are nearly ready for publication.

UNIVERSITY OBSERVATORY, LUND.

(Professor AXEL MÖLLER, Director.)

The refractor was used by Dr. Dunér on making observations on double stars; U. Geminorum and V. Coronæ were observed by him systematically and over 1,500 spectroscopic observations made.

Dr. Lindstedt determined comparison stars for the refractor observations.

Observations for the zone + 35° to + 40° were commenced and continued during the second half of the year. The programme contains 11,200 stars, of which, owing to unfavorable weather, only 1,183 could be observed.

UNIVERSITY OBSERVATORY, MANNHEIM.

(Dr. W. VALENTINER, Director.)

The observations on the cluster G. C. 4410, of which the densest portion had been previously observed, were extended farther to the north. Seventy-one stars were determined by observation of the differences of 3168 right-ascensions and of 1507 declinations. The second group G. C. 1166 contains 36 stars with observations of differences for 1570 right-ascensions and 594 declinations. The results of the observations on the above groups are in the hands of the printer, and expected soon to be ready for distribution.

Of group G. C. 1454, only a few measurements were obtained. Of this group 2 stars were noted as double stars (A. O.″ 5645 and—10^s,—1′.7).

Measurements in G. C. 1119 will be commenced shortly.

The reduction of the meridian observations of Barry has been printed in the "Jahresbericht des Mannheimer Vereins für Naturkunde" and distributed.

Money has been appropriated for the purchase of a transit instrument. The Reichenbach Repeating Circle is to be changed into a meridian circle.

UNIVERSITY OBSERVATORY, MILAN.

(Prof. M. SCHIAPARELLI, Director.)

During the year ill-health prevented the usual activity in the use of the refractor, and only 102 double stars were measured. No comet was observed. Advantage was taken of this inactivity to examine the periodic errors in the micrometer screw, which was done twice; the micrometer, meanwhile, being taken apart and cleaned. The errors discovered were very small, less than 0″.04.

The northern hemisphere of Mars being somewhat free of snow during first four months of 1878, I was able, in some measure to complete the topographical map of that planet made during the previous year. During the same period we observed the aspects of Venus, and made many sketches before and after the inferior conjunction. The results were not satisfactory, but we will continue observations for two other inferior conjunctions to have the aspect under all geocentric longitudes.

Professor Celoria has reduced the meridian circle observations made during 1871–'2. In the first six months of 1878 he made with this instrument 1,200 observations on stars of rapid movement and on the principal ones of the new doubles of Mr. Burnham. In the last six months the construction of the adjoining tower of the registering anemograph has prevented observations with the circle. In the mean time Professor Celoria devoted himself to preparing for publication his calculations of longitudes made in 1875, and continued his studies of ancient eclipses.

The determination of time for the use of the observatory and the city has been made by Dr. Frisiani—who also has charge of the meteorological observations—and assistant, Dr. Rajna.

A new equatorial refractor of 18 French inches aperture is being made for the observatory by A. Repsold, of Hamburg.

UNIVERSITY OBSERVATORY, MOSCOW.

(Dr. TH. BREDICHIN, Director.)

Professor Bredichin continued his spectroscopic observations of the Sun, observed on Jupiter, and made microscopic measurements of the star Algol and of some star-groups.

The tails of the following comets were computed by him: 1577, 1618 (3), 1665, 1807, 1811, 1823, 1835, 1843 (1), 1845 (3), 1853 (2), 1853 (3), 1853 (4), 1854 (2), 1854 (3), 1857 (3), 1858, 1860 (3), 1862 (2), 1863 (4), 1877 (2), and a memoir published on comets.

Mr. Ceraski continued his photometric observations of stars.

Messrs. Belopolski and Socoloft observed the August meteors, and made a series of meridian observations of stars with independent motion, and examined the errors of the microscope and of the meridian circle.

Mr. Belopolski continued his photographic observations of the Sun.

ASTRO-PHYSICAL INSTITUTE, POTSDAM.

The buildings are progressing and some of them are being occupied, temporarily, by the laboratory and the library. A temporary structure was erected in 1874, for heliographic experiments.

The erection of the large refractor has to be delayed until next spring. The optical parts of the heliograph were purchased. Of smaller instruments were purchased:

A telescope by Schroeder $0^{m}.078$ aperture and $0^{m}.84$ focal distance; a comet-seeker of $0^{m}.076$ aperture; a 12-inch universal instrument by Repsold; a 5-inch reflector by Pistor and Martins; a $\frac{3}{4}^{s}$ clock by Tiede; a small star-spectroscope and an astatic mirror-galvanometer by Siemens and Halske.

For time-determinations a small transit was borrowed of the Berlin-Observatory.

Dr. P. Kempf, of Berlin, has been employed as assistant.

The observations on sun-spots and protuberances were continued by Professor Spörer, assisted by Dr. Kempf. No spots were visible in 173 days out of 245 days of observation.

The mean heliographic latitude of the spots amounted to ±7° in the first four months, ±9° in the second, and in the last four months they were visible only in the northern hemisphere. Only a small number of the days were favorable for protuberance observations. Professor Spörer completed the arrangement of the sun-spot observations for 1871–1873, and, assisted by Dr. Kempf, computed those measured in the years 1874–1878.

Dr. Vogel and Dr. Müller continued the examination of the solar spectrum.

Spectroscopic observations of fixed stars and nebulæ were made by Dr. Vogel. With the instruments employed could be seen those nebulæ mentioned by Herschel as "pretty bright," and under favorable conditions the observer could determine the character of the spectrum of the nebulæ termed "faint." Only 54 nebulæ spectra were examined.

The examination of the surfaces of planets was continued by Dr. Lohse with the 7½-inch telescope; 38 drawings were made of Jupiter and observations made on Saturn.

Dr. Lohse took photographic views of the Sun, a large number of which were made with a photographic telescope of $0^{m}.057$ aperture and $1^{m}.5$ focal distance. He also experimented in the laboratory on the new and, in astro-photography, important process of employing gelatine in place of collodion.

Dr. Müller made determinations of refraction in various kinds of glass intended for use in astronomical instruments. He also continued his photometric researches.

Observations were made on 63 days on Mercury, Venus, Mars, Jupiter, Saturn, Uranus, Neptune, and Vesta, the comparison of which was made either direct or with Capella, and on fixed stars.

The time-determinations were made by Dr. Kempf with the refractor and by meridian observations with Ertel's transit.

The transit of Mercury was observed and the meteorological observations continued in the usual manner.

Publications of the Observatory.

1. Notices on observations of the new star in the Swan, by Dr. Vogel.
2. Report on the Transit of Mercury.
3. Observations on the sun-spots from October, 1871, to December, 1873, by Professor Spörer.
4. Observations and researches on the physical condition of Jupiter, and observations on Mars, by Dr. Lohse.
5. On the origin of protuberances by chemical processes, by Professor Spörer.
6. Dr. Vogel's report on the observations of the solar spectrum is in press.
7. The star-group χ Persei, observed in the years 1867–1870 with the 8-inch refractor of the Leipzig Observatory, by Dr. Vogel.

UNIVERSITY OBSERVATORY, STOCKHOLM.

(Dr. HUGO GYLDÉN, Director.)

The work of the observatory has quite unexpectedly been interrupted by the sickness of the director and by the resignation of the assistants. At present the personnel is again complete, Mr. C. A. Lindhagen being first and Mr. H. Branting second assistant, with Mr. Rankin, of Helsingfors, assisting temporarily.

Examination was made of the error in the division of the meridian circle, mainly performed by Mr. Jäderin, and to be described by him in a special report.

The observations commenced in 1877, with the view of determining relative parallaxes by registration of differences of right ascension of stars close together, has to be delayed on account of the sickness of the director. The observations made thus far refer to the following stars:

α Cassiopeiæ.
μ Cassiopeiæ.
β Andromedæ.
ϑ Persei.
ι Persei.
α Persei.
α Aurigæ.
No. 61 of Argelander's Catalogue.
β Aurigæ.
ζ Herculis.
β Lyræ.
ν Lyræ.
ε Cygni.
61 Cygni.
ζ Cygni.
τ Cygni.
No. 240 of Argelander's Catalogue.
ι Andromedæ.

UNIVERSITY OBSERVATORY, STRASSBURG.

(Prof. A. WINNECKE, Director.)

One hundred and seventy-eight observations on 118 nebulæ were made in 41 nights. A very considerable periodic variability of brightness was recognized in the nebula *h* 882 = H I. 20, and is very probable in nebula *h* 1061 = H IV, 56.

Sixteen observations were made of Nova Cygni. Not much progress was made in the comparative observations of double stars. The attendant of α Scorpii was observed on the 18th of July.

A series of observations was commenced on the double star Σ 1516.

The environs of Kepler's and Tycho's Nova were observed several times.

Of variable stars minima were observed by Dr. Winnecke of S Cancri, Algol, λ Tauri, U Coronæ, and the maximum of Mira Cetti.

Swift's comet could not be found; Tempel's periodic comet was seen on several occasions.

The conjuction of Mercury and Venus was observed on September 30.

Dr. Schur observed for time with Cauchoix's transit; 34 culminations of the first and 29 of the second limb of the moon were observed, and the opposition and quadratures of Jupiter, Saturn, Uranus, and Neptune.

Seventy-one comparison-stars were determined. Dr. Schur and Mr. Hartwig continue with the heliometer the series of measurements of the solar diameter; 54 measurements were obtained by Dr. Schur. The minimum of Algol was observed twice, that of λ Tauri once.

A series of observations with the large spectroscope was commenced on the refraction of the two kinds of glass employed by Merz in the construction of the 18-inch objective.

Mr. Hartwig obtained measurements with the heliometer of the polar-diameter of the sun on 103 days, and of the equatorial diameter on 106 days. The same instrument was employed by him to locate the moon's craters: Mösting A; Hypatia B; Lapeyrouse.

The diameter of Mars and Venus were measured 2 and 7 times, respectively; the distances of η, 17, and η, 27 Tauri observed in 7 nights, and the 5 star-distances in Cygnus 5 times each.

The heliometer was improved (by Messrs. Repsold) by a new position-circle.

The large comet-seeker was employed, Mr. Hartwig obtaining 2 maxima of R Vulpeculæ and T Herculis, maximum of V Cancri, S Coronæ, R Orionis, S and T Ursæ Majoris, R Aquilæ, R and S Herculis, R Draconis, S Geminorum, R Camelopardi; 2 minima of S Ursæ Majoris, and the minimum of R Draconis and minima of Algol.

Observations were made on transit of Mercury on the partial eclipse of the moon and the eclipses of the satellites of Jupiter.

The following instruments were purchased: A prism-circle by Steinheil, one Merz telescope of 101^{mm} aperture, one Plössl of 76^{mm} aperture, and a Paris theodolite which has been changed to a spectrometer. A 2-foot Leibherr repetition-circle was presented by Director Merz.

The buildings for the new observatory are well under way, and it is hoped that they will soon be ready for occupation.

IMPERIAL OBSERVATORY, VIENNA.

(Dr. E. WEISS, Director.)

Owing to financial complications less progress was made in the construction of the new observatory than was anticipated. The most important part of the work consisted in the erection of the large dome. The interior of the building is in a sufficiently advanced state to permit the occupation.

But little hope is entertained that the new meridian circle and the large refractor can be obtained this year. As a consequence the instruments of the old observatory, with the addition of a 11⅔-inch Clark refractor and a 6-inch comet-seeker, will have to be used.

The activity in the old observatory was very limited. Dr. Holetschek determined with the meridian circle the position of those stars which were selected as fundamental points for the Vienna zones between + 15° and + 18° declination. He also observed a few asteriods.

Mr. A. Palisa continued the observations with the 6-inch refractor of the asteroids until August, when Mr. E. Glaser took his place. Comparatively small results were obtained.

Volume 27 of the Annales of the Observatory, published last summer, contains, besides a necrology of C. v. Littrow, the paths of 2,685 meteors and those of 1,175 meteors observed in Vienna between the years 1840–1845, not reduced and published before; and finally the meteorological observations of 1877.

Volume 28 of the Annales, just in press, will be devoted mainly to zone observations.

ASTRO-PHYSICAL OBSERVATORY, WILHELMSHAVEN.

(Dr. C. BÖRGEN, Director.)

The buildings were completed in July, 1878, and occupied in August.

The principal instrument is a meridian circle by Repsold of 120^{mm} aperture, 1.5^{m} focal distance, 2 circles of 0.5 diameter, and is furnished with level, 2 collimators of 67^{mm} aperture, and an artificial horizon.

The standard clock is one of Tiede's pendulums. A second clock of inferior quality is located in the chronometer room, and is used both for comparison of chronometers and as clock for the registering apparatus in the meridian room.

A Steinheil refractor of 3½″ aperture is used for astronomical observations, and some astro-nautical instruments for practice.

The observatory possesses meteorological instruments and a self-recording apparatus for tidal observations, a collection of such magnetic instruments as are used on shipboard, and a model for the study of the deviation of the magnetic needle produced by the iron of a ship.

The activity of the observation is fourfold:

1. Astronomical, including time-service.

2. Meteorological; the observations are being published monthly in the "Annalen der Hydrographie."

3. Physical, the registering of magnetic and tidal observations; and

4. Nautical, comprising the examination of chronometers and barometers, and the determination of the compass deviation on shipboard.

Tides have been observed at various places and the observations discussed. Only one series, the one of Wilhelmshaven, has been printed in the Annales; but as a result of the observations tidal tables for the Baltic Sea have been published by the hydrographic bureau of the imperial navy.

Time signals were received from the Berlin Observatory during the earlier stages of its time-ball service.

Observations with the meridian circle were made on the Moon and such objects as are connected with it, including Uranus and Neptune.

The meteorological observations have been continued uninterruptedly.

Observations are being made on declination, inclination, and intensity of the terrestrial magnetism.

The *personnel* of the institute has been increased by the appointment, as assistant, of Dr. Andries.

UNIVERSITY OBSERVATORY, ZURICH.

(Dr. Rudolf Wolf, Director.

Observations on frequency of sun-spots were made whenever practicable, and the notes on sun-spot literature continued in the "Astronomische Mittheilungen." For determination of position of the spots, observations could be taken only on sixteen days, and were conducted by Mr. Alfred Wolfer.

Comparisons of Mairet's clock (standard) for sidereal time were made by Mr. Wolfer, who also recorded a number of observations with the equatorial and micrometric measurements, made 2 drawings of Venus, 52 of Jupiter, 18 of Saturn, and observed the transit of Mercury.

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no. 2

L.O. from E.S.H.

AN ACCOUNT OF THE PROGRESS
IN
ASTRONOMY
IN
THE YEAR 1885.

BY

WILLIAM C. WINLOCK.

FROM THE SMITHSONIAN REPORT FOR 1885.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1886.

ASTRONOMY.

By WILLIAM C. WINLOCK,

Assistant Astronomer, United States Naval Observatory.

The following record of the progress of Astronomy during the year 1885 is in continuation of the records of past years, and it is given in essentially the same form. The annual review of astronomy has previously been prepared by Prof. Edward S. Holden, formerly director of the Washburn Observatory, Madison, Wis.; and the manuscript of the review for 1885 was entirely prepared by him in October and November of that year. Very unfortunately all but a small portion of this manuscript was lost in transferring Professor Holden's library from Madison to California, and Professor Holden, unable, on account of pressing official duties, to repair the loss, has asked me to make up the deficiency. This I have attempted to do, but wish to record the circumstances here, in order that I may plead the brief time available as an excuse for any shortcomings that may be found.

This record is primarily intended for the large and increasing class of those who have a general rather than a special interest in the progress of Astronomy, but it may be of use to professional astronomers also, as a convenient collection of reviews and notes. Abstracts of some of the most important papers are given, while other papers can appear by title only. As in previous years free use has been made of reviews, &c., in all accessible periodicals, particularly of those in *The Observatory*, *Bulletin Astronomique*, *Nature*, *The Athenæum*, and *Science*, and it is hoped that where specific reference to the source of information has been impracticable, this general acknowledgment will be accepted.

W. C. W.

COSMOGONY.

Faye: Sur l'Origine du Monde. Théories cosmogoniques des Anciens et des Modernes. Paris: Gauthier-Villars, 1884. *8vo.*—"Cosmic hypotheses vary from time to time; they have their history, in which they reflect the progress of human intelligence. At first closely connected with religious ideas, they have little by little lost their sacred character, and have become simple questions of celestial mechanics and general physics.

It cannot be denied, moreover, that they offer a broad field for the discoveries and theories that from time to time transform and, as it were, renew science. The mechanical theory of heat and spectrum analysis have inaugurated a new era for speculations concerning the origin of the world and the constitution of the universe, by furnishing to theoretical reasoning a basis incomparably more sure than that possessed at the time of Laplace. It is quite natural, therefore, that scholars should again turn their attention to the chaos from which the stars were born, and that, with the aid of the knowledge gained during the last century, they should undertake to submit the current cosmical theories to searching examination.

"M. Faye's book upon this subject will be welcomed, as it comes at a moment when attention is everywhere beginning to turn to these obscure and sublime questions. A large part of the book is devoted to the history of cosmogonies, beginning with that of Moses; and every reader will be pleased that M. Faye has taken pains to give always the original text, accompanying it by comments and remarks. The book contains extracts from *Genesis*, Plato's *Timæus*, Aristotle's *Heavens*, Cicero's *De Republica*, the poem of *Lucrece*, Descartes' *World*, Newton's *Principia*, Kant's *Allgemeine Natur-Geschichte und Theorie des Himmels* and *Beweisgrund zu einer Demonstration des Daseins Gottes*, Laplace's *Exposition du Système du Monde*, and from M. Hirn's *Analyse élémentaire de l'Univers*. After this historical exposition of ancient and modern cosmical ideas M. Faye proceeds to consider in his turn the problem of the formation of the universe and of the solar system.

"M. Faye regards Laplace's celebrated cosmic hypothesis, which is still accepted in treatises on astronomy, as quite opposed to science in its present state; he says that it cannot be reconciled with the retrograde motions of the satellites of Uranus and Neptune, nor with the rapid revolutions of Mars' satellites, nor with our notions of the rings of Saturn. M. Faye proposes to replace this hypothesis by another one more conformable to existing ideas, taking its point of departure in Descartes' vortices." (*Bull. Astron.*, February, 1885.)

"Prof. G. H. Darwin has contributed to *Nature* (Vol. 31, p. 506) an interesting and valuable criticism of M. Faye's theory of the evolution of the solar system as explained in his paper in the "*Annuaire du Bureau des Longitudes* for 1885, and also in his work entitled "*Sur l'Origine du Monde.*" The best general idea of the line of speculation adopted by M. Faye may be given by saying that it is a theory of evolution from meteorites, instead of from the nebulous matter which gives its name to Laplace's theory. In the primitive condition, the universe consisted of matter scattered in chaotic confusion. Currents were generated in the midst of this chaos under the influence of mutual gravitation; and in consequence of these movements, shreds of matter became detached and moved with rapid linear and slow gyratory motion. The solar system is taken to have originated from a shred which aggregated into a spheroidal shape and consisted, at the epoch when we began to watch it, largely of separate meteorites. It is at first supposed that the spheroidal aggregate consists of matter pretty nearly equally distributed, and later a nucleus is formed. If r be the distance of any point from the center, the force is central and follows the law $ar + \frac{b}{r^2}$ where, in the beginning of the evolutionary process, b is very small, and later a becomes small. Initially, then, when the force is simply as the distance, each meteorite moves in an ellipse about the center, and the periodic time of all is the same, whatever their eccentricity of orbit. In consequence of collisions, a central nucleus is soon formed; as this increases, the a in our formula for the force diminishes and the b increases, but orbits which are circular still retain that form, notwithstanding the progressive change in the law of force. At the same time that the nucleus is being formed, a series of flat and nearly circular rings arise around it, those near to the nucleus attaining a definite shape sooner than the remote ones. It is not adequately explained why the matter should be sifted, and should arrange itself in rings at definite intervals around the nucleus, still less is any light thrown on the law of Titius concerning the distances of the planets from the sun. Considering now the case of the first ring, M. Faye supposes that slight differences of angular velocity, mutual attraction, and collisions gradually cause the aggregation of all the matter in the ring around some center in its line. When the nucleus is small, the rings moved as a rigid whole, and the linear velocity of the outer meteorites was greater than that of the inner ones; therefore when the planetary aggregate is formed, it will be found rotating with direct motion about an axis nearly perpendicular to the plane of its orbit. As we proceed from the first ring outwards, in each successive case the tendency to direct motion is weaker, because the increase of the solar nucleus by absorption of meteorites has prevented so large an excess of linear velocity of the outer meteorites over those of the inner ones as in the first case. By degrees, therefore, we come to planets in which the meteorites move nearly according to Kepler's laws, and here the resulting planet has a retrograde rotation. Each planetary agglomeration in its turn forms a miniature solar system, and generates satellites by the same process as that in which the planets were formed. After having thus sketched M. Faye's theory in its main outlines, Professor Darwin points out that no reference is made to the possible effect of tides in the evolution of the solar system, a part of the subject which has been so ably worked out by Professor Darwin himself. He has shown that the hypothesis that tidal friction has had free play in the past leads to a remarkable quantitative co-ordination of the several elements of the earth's rotation and of the moon's orbital motion, and points to the genesis of the moon close to the present surface of the earth. The rapid orbital motion of the inner satellite of Mars confirms in a remarkable way the truth of the hypothesis. It also throws light on the cause of the observed distribution of satellites in the solar system. It is, in Professor Darwin's opinion, a factor which cannot be left out of account, and has a bearing on theories of evolution which cannot be neglected. Professor Darwin's paper concludes with a summary of the advantages and disadvantages of M. Faye's scheme. The conception of the growth of planetary bodies by the aggregation of meteorites is a good one, and perhaps more probable than the hypothesis that the whole solar system was gaseous. The internal annulation of the meteorites is left unexplained, and this compares very unfavorably with Laplace's system, where the annulation is the very thing explained. The difference of orbital motion of the inner and outer meteorites of a ring, the development of that difference as time progresses, and the consequence of direct and retrograde rotation at different distances from the sun, is an excellent idea. But it is necessary to this idea that the inner planets should have been formed first,* and we are met directly by the fact that the single surviving ring, that of Saturn, is nearer to the planet than are the satellites, and we should be driven to the startling conclusion that Saturn's ring is the oldest feature of his system. The actual distribution of satellites in the solar system is at variance with M. Faye's theory, for as, according to him, the internal planets were generated from rings whose motion was such as would give greater moment of momentum to the planetary agglomeration than would the external ones, the number of satellites should be greater the greater the amount of rotation in the primitive agglomeration of meteorites, and thus the nearer planets should be richer in satellites than the remote ones. On the whole, then, there are great difficulties in the acceptance of M. Faye's scheme, notwithstanding its excellences; but science is undoubtedly the gainer by such suggestive theories." (*Observatory.*)

For further discussion of these interesting questions we must refer the reader to the valuable articles of MM. Radau and Wolf in Volumes I and II of the *Bulletin Astronomique*, and to a paper by Prof. Daniel Kirkwood, read before the American Philosophical Society (November 21, 1884) and published in the April number of the *Sidereal Messenger*. We are glad to learn that M. Wolf intends to elaborate his discussion still further, and that it will be brought out in book form by the publishing house of Gauthier-Villars.

NEBULÆ.

New nebulæ.—M. Stephan has published in the *Astronomische Nachrichten*, No. 2661, positions and descriptions of 100 nebulæ discovered at Marseilles in the years 1883–'85, in addition to the large number previously detected at that observatory. Not the least notable characteristic of M. Stephan's catalogues is the precision of the places given in them. He mentions that on October 1 and 2, 1882, neither the nebula Dreyer-Schultz 5085 nor *h* 12 was visible in the position assigned by the discoverers.

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* In fact, according to M. Faye, the earth is older than the sun. "If it were otherwise, the whole appearance of the sky would be changed; the stars would rise in the west and set in the east; the moon would have a retrograde motion like the satellites of Uranus and Neptune." (*Sur l'Origine du Monde*, p. 192.)

Professor Swift gives in the *Astronomische Nachrichten* two catalogues of nebulæ discovered in 1883–'85 with the 16-inch refractor of the Warner Observatory. Each catalogue contains 100 nebulæ and gives approximate positions for 1885·0, with descriptive notes. All of these nebulæ belong to the fainter classes, and the increased difficulties in dealing with such objects since the appearance of our "red sunsets" have been remarked by Professor Swift, as well as by other observers. Professor Swift has a list of some 150 more nebulæ, which will require further study before publication.

Several shorter lists of nebulæ, found by Tempel, Barnard, and others, generally in the search for comets, will be found in the various astronomical journals.

General catalogue of nebulæ.— Apropos of Dr. Holetschek's letter (*Astron. Nachr.*, No. 2664) concerning the regular publication of supplementary catalogues of new nebulæ, double stars, red stars, &c., Dr. Dreyer announces that he is preparing a second supplement to Sir John Herschel's Catalogue of Nebulæ.

Discovery of a new nebula in the Pleiades by photography.—Probably the most notable achievement in celestial photography during the year has been the discovery by MM. Paul and Prosper Henry, at the Paris Observatory, of a new nebula in the group of the Pleiades. It was first photographed on November 16, 1885, and, though it was again photographed on December 8 and 9, MM. Henry have as yet been unable to detect it by direct telescopic observation. The nebula is about 3′ in extent, and "*très-intense.*" It presents a well marked spiral form, and seems partially to surround the star Maia.

Professor Pickering writes, under date of January 21, 1886, to the editor of the *Nachrichten* in regard to this interesting discovery, as follows:

"The announcement of this nebula in the *A. N.*, vol. 113, p. 239, recalled the circumstance that certain irregularities had been noticed in a photograph of the Pleiades, taken on November 3, 1885, at the observatory of Harvard College, with an exposure of sixty-five minutes. This photograph was exhibited at the Albany meeting of the National Academy of Sciences, November 10, where the irregularities above mentioned received some attention. They were supposed to be due merely to defects in the photographic process; but upon re-examination it appears that one of them corresponds so closely to what is described by MM. Paul and Prosper Henry that there can be no doubt in regard to its origin. It must represent light photographically perceptible in the vicinity of the star Maia, as stated by its discoverers. - - - The explanation thus afforded of one of the markings on the Cambridge photograph makes the others of more interest than seemed at first to belong to them. There are indications of nebulous light about Merope; four short parallel streaks directly to the south following side are particularly noticeable, and a faint prolongation of diffuse light may be suspected towards the south, in agreement with the descriptions usually given of the visible nebula in that region. There is also a faint narrow streak of light projecting from Electra on the following side. All the bright stars are surrounded by concentric bands, obviously due to effects of reflection from the back of the plate and from the inner surfaces of the lenses. These bands interfere to some extent with the appearances of nebulous light above described, and are most conspicuous around Alcyone, as would be expected from the brightness of that star. No nebulous light is noticeable about Alcyone, Atlas, Pleione, or Taygeta."

Professor Struve announces that he has seen the nebula about Maia very distinctly with the great 30 inch refractor of the Pulkowa Observatory. We learn also from later reports that the nebula has been seen and sketched at the Nice Observatory.

Photographic study of the nebula of Orion.—Prof. E. C. Pickering has made a comparison of the results of photographic and eye observations of this region, comparing the star magnitudes as given by the photographs of Dr. Draper and Mr. Common, with the catalogue of Professor Bond. His results will be found carefully tabulated in the twentieth volume of the *Proceedings of the American Academy*. One of the most important applications of the determination of photographic magnitudes is to the measurement of the colors of the stars. The rays affecting the photographic plate have in general a less wave length than those to which the eye is most sensitive. It therefore follows that a reddish star, that is, one in which the rays of great wave-length predominate, will appear relatively too faint in the photograph. A bluish star is similarly indicated by a large negative residual (on comparison with eye estimates). These residuals form a convenient measure of the colors of the stars; and Professor Pickering gives a list of ten red stars, thus indicated on the plate, varying from 10·7 to 13·9 magnitude, according to Bond, and ten blue stars, varying from 12·3 to 15·6 magnitude. "The faintest stars visible in the photograph have a photographic magnitude of about 15·0."

Variability of a nebula.—"The nebula near the star ζ Tauri seems to present an interesting instance of variability of light. This nebula was observed by Chacornac at Paris on the 19th of October, 1885, surrounding a star of the 11th magnitude, which had repeatedly been observed in 1854, and also at Markree in January, 1850, without any nebulosity being noticed. In January, 1856, Chacornac found this very bright and conspicuous, resembling in its appearance a transparent cloud, reflecting the light of ζ Tauri. But in November, 1862, he could discern no trace of the nebulosity; and D'Arrest also failed to see it when observing the star with the Copenhagen refractor on the 25th of January, 1865. Nor has it since been seen until quite recently, when it was noticed by Mr. K. Tarrant, using a 10-inch 'With' reflector, at Pinner, Middlesex. D'Arrest had noticed a small star of less than the 12th magnitude, a little preceding the 11th magnitude star previously mentioned, and nearly on the same parallel with it. When the nebula was first seen by Mr. Tarrant (on the 14th of March, 1885), it was lengthened in the direction of a circle of declination, and this faint star was at its following edge. The first known instance of this kind was that of the nebula near ε Tauri, discovered by Mr. Hind in 1852, suspected to be variable from not having been seen before, and afterwards proved to be so, becoming invisible even with very powerful telescopes, and subsequently reappearing." (*Athenæum.*)

ASTRONOMICAL CONSTANTS, ETC.

A new determination of the nutation constant.—"Dr. L. de Ball has employed for this determination the right ascensions of three polar stars (α and δ Ursæ Minoris and 51 Cephei), observed at Pulkowa by Herr Wagner, part of which have already been employed by Herr Nyrén in his researches concerning the constant of aberration." (*Bulletin Astron.*, I, p. 202.) Although these observations, which were made between 1861 and 1872, embrace only a little more than half a complete period of nutation, their precision is such as to justify Dr. de Ball's attempt. He has had at his disposal 934 eye-and-ear observations and 933 chronograph observations. The mean error of an observation is nearly the same for the two methods. By introducing as unknown quantities the corrections to the mean right ascensions of the three stars to the nutation constant (Peters) and to the aberration constant (Struve), and also the parallaxes of the stars under consideration, Dr. de Ball has attained the following results:

	″	″
Correction to the nutation constant Δn	−0·006	± 0·012
Correction to the aberration constant Δa	+0·043	± 0·011
Parallax of α Ursæ Minoris	+0·015	± 0·015
Parallax of 51 Cephei	+0·027	± 0·019
Parallax of δ Ursæ Minoris	+0·034	± 0·017

	s	s
R. A. (1865·0) of α Ursæ Minoris (eye and ear)	$1^h\ 9^m$ 38·706	± 0·043
R. A. (1865·0) of α Ursa Minoris (chronograph)	39·057	± 0·051
R. A. of 51 Cephei (eye and ear)	$6^h\ 36^m$ 11·723	± 0·026
R. A. of 51 Cephei (chronograph)	12·012	± 0·027
R. A. of δ Ursæ Minoris (eye and ear)	$18^h\ 15^m$ 53·084	± 0·020
R. A. of δ Ursæ Minoris (chronograph)	53·363	± 0·020

"The six values of the correction Δn furnished by the three stars do not show a very remarkable agreement:

	Eye and ear.	Chronograph.
α Ursæ Minoris	−0″·062	−0″·011
51 Cephei	+0″·028	+0″·003
δ Ursæ Minoris	−0″·016	+0″·039

"The individual values of Δa, computed by Dr. de Ball, differ quite widely in some cases from the values obtained by Herr Nyrén from the same observations, and it seems impossible to discover the cause of these differences. It is without doubt necessary to take into consideration the influence which the motion of the solar system might exert upon the aberration in the case of stars near the pole, as has been shown by Dr. Seeliger." (*Bull. Astron.*, July, 1885.)

The secular nutation of the earth's axis.—"M. Folie, having deduced a periodic formula for the secular variations in obliquity and in longitude, applies the designation 'secular nutation of the earth's axis' to these variations. Defining the normal equator as a plane, the inclination of which to the ecliptic of a certain epoch is equal to the mean obliquity of that epoch, and the intersection of which with this latter plane passes at each instant through the mean equinox of that instant, he concludes that, in virtue of the secular nutation of the earth's axis, the mean pole describes around the normal pole, considered as fixed, an ellipse the major axis of which, directed towards the pole of the fixed ecliptic (*i. e.*, the mean ecliptic of the epoch), is sensible during several centuries. The period of the secular nutation is about 30,000 years, differing little from that of the precession on account of the slow motion of the node of the ecliptic, which is only $8''\cdot7$ per annum. Assuming a uniform value of $50''$ for the secular diminution of the obliquity, M. Folie compares the results obtained from his formula with ancient observations of the obliquity, and is thus led to announce that the empirical expression $\varepsilon_1 = 0''\cdot476 + 0''\cdot000018t$ for the annual diminution (where t is the number of years from 1850) satisfies very closely the observations from -250 to $+1487$. This expression, however, gives a considerably greater variation to the secular diminution of the obliquity than that which results from Leverrier's researches." (*Nature.*)

Precession tables.—In the *Monthly Notices* for December there will be found tables by Mr. Rambaut for the reduction of Bessel's precessions to those of Struve.

Astronomical refraction.—M. Lœwy has recently communicated to the *Académie des Sciences* an account of a method which he considers to be especially adapted for determining the constant and other elements of refraction. The principle of the method is this: A glass prism with silvered faces, forming a double mirror, is placed in front of the object glass of an equatorial. By means of this arrangement the images of two stars which are widely separated in the sky can be brought close together in the focal plane of the telescope; thus one star may be at the zenith and the other on the horizon, in which case the measured distance between the images will be largely affected by refraction. After an interval of three or four hours, when the stars are at an equal height above the horizon, and when, therefore, the effect of refraction is a minimum, the distance between the images is again measured. The comparison of these two observations gives the means of determining the amount of the refraction with great accuracy. It is of course necessary for the success of the method that the measures should be absolutely independent of every possible displacement of the apparatus in the interval between the observations. This result is obtained by placing the double mirror in such a position that the planes of reflection for the two stars coincide, as M. Lœwy finds that under these circumstances, whatever small displacements the mirror may undergo, the distance between the images in the field of the telescope, measured in the plane of reflection, or the projection of this distance on the trace of the plane of reflection in the field, remains invariable. M. Lœwy claims for this method that, on account of its simplicity and the ease with which it can be put in practice, it completely solves the problem to which he applies it. A few experiments ought to show whether it is capable of affording results sufficiently accurate to make the method of practical value. (*Observatory.*)

STAR CATALOGUES, ETC.

Glasgow catalogue.—"The Glasgow Catalogue,* recently published by Mr. Robert Grant, is the subject of a very detailed review by Dr. Auwers in the *Vierteljahrsschrift* for 1884. The catalogue depends upon observations made since 1860 by the Ertel meridian circle, and comprehends, besides some hundreds of bright stars selected from the B. A. C., more than 6,000 telescopic stars from Weisse's first catalogue. The stability of the instrument has been satisfactory, although not comparable with that of the Greenwich circle. The process of reduction employed by Mr. Grant is not entirely beyond criticism. Dr. Auwers has undertaken a minute comparison of this catalogue with that of the *Astronomische Gesellschaft* in order to determine the relative precision of Mr. Grant's positions. He finds the mean error of these positions to be ± 0ˢ·06 and ± 0″·9 for the unit of weight (which depends upon the number of observations). This mean error being 0ˢ·04 and 0″·6 for the best catalogues, Dr. Auwers thinks the relative weight, one-half, may be attributed to the Glasgow positions." (*Bull. Astron.*, March, 1885.)

Cordoba Zone catalogue.—"In a notice in the *Observatory* for January, 1885, devoted to Dr. Gould's zones, Mr. Downing shows the high value of this great work, which it has required no less than thirteen years to bring to completion. We already owe to Dr. Gould the *Uranometria Argentina*, which the Royal Astronomical Society honored in 1883 with its gold medal. The publication of a general catalogue is looked for soon, and this, with the catalogues of the Cape and Melbourne, will measure the extent of our knowledge of the southern heavens.

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* Catalogue of 6,415 stars for the epoch 1870, &c., by Robert Grant. Glasgow, 1883. 4to.

"The zone observations were commenced in 1872. The total number of observations is more than 105,000 for 73,160 stars, between —23° and —80° of declination, the lowest magnitude being the 10th. The Repsold meridian circle is reversible; the objective has an aperture of 122^{mm}, and a focal length of $1^{m}\cdot463$; the divided circle has a diameter of $0^{m}\cdot716$, and the readings were made by means of four microscopes. In the zone observations it was the rule to observe the transits over three threads, and to read but one microscope. The right ascensions depend upon the positions of Dr. Gould's fundamental stars, published by the Coast Survey, and nadir observations have been made concurrently with observations of polar distance. The mean error in right ascension is $0^{s}\cdot062$, and in declination $0''\cdot97$. The observations were made under the best conditions, and no pains have been spared in determining accurately the instrumental errors and in verifying the reductions." (*Bull. Astron.*, February, 1885.)

The stereotype plates of this catalogue have been placed in the custody of the *Astronomische Gesellschaft.* We make the following extract from a letter of Dr. Gould's in regard to the matter: "The recently published catalogue, formed from the Cordoba Zones, was printed from stereotype plates, in order that any errors discovered up to the last moment might be corrected before the work should be actually printed. The plan has proved successful, and I believe the catalogue to be more than usually correct; nevertheless, a considerable number of errors have been detected since it was printed, and a list of these will soon be sent to the *Astronomische Nachrichten.* I have now been charged by the Argentine Government with the agreeable duty of causing the recently detected errors to be corrected upon the stereotype plates, and offering these to the *Astronomische Gesellschaft*, for its acceptance, in case the gift should not be considered too burdensome. - - - It is of course understood that the gift of the plates carries with it the fullest authority for the *Astronomische Gesellschaft* to use them for printing a new edition whenever it may see fit."

Catalogue of 1,001 *southern stars.*—Volume 3 of the Publications of the Washburn Observatory contains a catalogue of 1,001 stars between 18° and 29° 39′ of south declination, formed by Rev. Father Hagen and Professor Holden from a series of 2,161 observations made by Professor Tacchini with the Pistor and Martins meridian circle at Palermo in the years 1867, 1868, 1869. The observations were originally published in the *Bullettino Meteorologico del R. Osservatorio di Palermo* from April, 1867, to July, 1869, where the apparent place and epoch are given, and Professor Holden says that the existence of this valuable material became known to him through the admirable *Vade-Mecum* of M. Houzeau. The stars observed are from the 6th to the 9th magnitude, and the magnitudes appear to have been very carefully noted, while it is remarked that the positions are excellent. They are reduced to the year 1850·0, but the mean epoch of observation of each star is appended.

Professor Holden and Father Hagen have also derived the places of 437 southern stars for 1850.0 from Washington transit-circle observations, and these places have been compared with positions given in the Cape Catalogue for 1880, the Cordoba Zones, and Yarnall's Catalogue. The comparisons are printed in the volume referred to above, and will be of value in deducing the relations of the various systems adopted.

The "anonymous" stars of Yarnall's Catalogue.[*]—"Prof. E. Millosevich has published a useful contribution to exact astronomy in his paper, *Sulle Stelle boreali fino a* —1° *inclusivo dette 'Anonymous' del Catalogo di Yarnall* (Washington, 1878). It appears that between the limits +90° and —1° declination, Yarnall's Catalogue contains 732 stars which are designated as anonymous. Professor Millosevich has carefully gone through these, comparing them with the DM., or with the catalogues of Weisse, Rümker, Struve, Lalande, or Oeltzen's Argelander, and has succeeded in almost every case (sometimes by making conjectural corrections to Yarnall's places) in identifying the star in the Washington Catalogue. The paper also contains a comparison of the estimates of magnitude made by the Washington observers and by Argelander in the case of these anonymous stars. After applying a systematic correction of +0·3 of a magnitude to Yarnall, Professor Millosevich finds that there are 33 stars which differ by 0·9 of a magnitude or more in the two catalogues, and gives a list of these with their places for 1860·0, as there is a strong presumption that they will prove to be variables. Taken in conjunction with Holden's List of Errata in Yarnall (*Astron. Nachr.*, No. 2561), Professor Millosevich's paper is a useful addendum to the Washington Catalogue for 1860." (*Observatory.*)

Professor Frisby, of the Naval Observatory, is now at work upon a third edition of *Yarnall's Catalogue*, in which it is intended to correct all the errors thus far detected.

Harvard College catalogue of 1,213 *stars for* 1875.—"This catalogue contains the results of observations made during the years 1870 to 1879 with the meridian circle of the Harvard College Observatory, the stars observed being chiefly those required for the revision of the *Durchmusterung* for the zone between the parallels of declination +50° and +55°. The star places employed as points of reference were taken from the list given in Publication XIV of the *Astron. Gesellschaft.* The right ascensions and declinations published in the catalogue are derived from a discussion of the results obtained during the whole period covered by the observations. They are given in their present form for the purpose of making them immediately available in advance of the publication of the volume which is to furnish the details of the investigation, viz, volume XV of the *Annals.* The observations were nearly all made by Professor Rogers, who has also had charge of their reduction and publication,—a statement which is a sufficient guarantee for the accuracy of the observations, and for the thoroughness of the reductions." (*Observatory.*)

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[*] *Annali della Meteorologia Italiana*, Part iii (1884).

Cape observations.—Dr. Gill has published, in one volume, the Cape Meridian Observations 1879–'81. During these years the Cape transit circle was employed in observing, in conjunction with Leyden, a list of fundamental stars required in the meridian observation of the stars between declination —1° and —20°, contained in Schönfeld's extension of the *Durchmusterung.* In addition to these, two further lists of stars were observed, one of which had large Z. D. at the Cape and small Z. D. at Leyden, the stars of the other list culminating near the zenith of the Cape and at small altitudes at Leyden. There were also observed during these years stars which were employed in the longitude operations connecting Aden and the Cape. (*Observatory.*)

Cape catalogue for 1850.—Dr. Gill has also recently published (no date of publication) a catalogue of 4,810 stars, the results of observations made at the Royal Observatory, Cape of Good Hope, from 1849 to 1852, under the direction of Sir Thomas Maclear. The right ascensions were observed with Dollond's transit, which was mounted in 1828, immediately after the erection of the observatory buildings. The north polar distance observations were made with the mural circle, which was mounted in 1829. "No proper motions are given in the catalogue, and none have been applied to the star places. The catalogue therefore represents the places of the stars at the epoch of observation, but reduced to the equinox 1850·0." For the purpose of determining systematic errors a comparison is given with the Cape catalogue for 1880, the separate results being given in a column marked "Cape 1880, *minus* Cape 1850."

Fundamental stars.—At the meeting of the Royal Astronomical Society on March 13, 1885, "Mr. Downing read a paper on the star places given in the *Nautical Almanac.* The star places in the *Nautical Almanac* for 1884 were derived from the *Nine-Year Catalogue,* while in 1883 and preceding years the *Seven-Year Catalogue* was employed. Mr. Downing has deduced the systematic discordances resulting from the change of catalogues. In considering the R. A.'s he found for 24 stars discordances greater than $0^s{\cdot}05$, their mean discordance being $0^s{\cdot}064$, which seems to indicate inaccuracies in the proper motions employed. If Dr. Auwers's results for these stars' proper motions are substituted for those of Main and Stone, the mean discordance is reduced to $0^s{\cdot}042$. It seems, then, desirable to adopt the proper motions that are the result of Dr. Auwers's researches. In one of the last volumes of the *Berliner Jahrbuch,* Dr. Auwers has made a comparative study of the positions of fundamental stars contained in the principal ephemerides, in particular the *Nautical Almanac.* He shows in this article that a sufficiently accurate allowance for the proper motions has not always been made.

"Mr. Downing read a second paper upon the R. A.'s of the Cape catalogues of 1850 and 1880. He has compared the R. A.'s of the catalogue of 1850 with those of the catalogue of 1840, those of the catalogue of 1880 with the Melbourne catalogue for 1870, and with the Cape catalogue for 1860. The results of the Cape for 1850 and 1880 have thus been referred to the mean of three other catalogues (Melbourne, 1870; Cape, 1840 and 1860). Mr. Downing's conclusion is that the discordances between the two Cape catalogues for 1850 and 1880 should not be laid to the account of the latter catalogue. There is an error of $0^{s}\cdot1$ at 140° polar distance." (*Bull. Astron.*, May, 1885.)

New methods of determining the co-ordinates of polars without the necessity of knowing the instrumental constants.—According to the usual method the instrumental constants are determined by supposing the co-ordinates of one or two polars to be known; these co-ordinates are corrected from time to time by the combination of all the available pairs of observations separated from each other by twelve hours; these pairs of observations are, however, rather rare. If the star observed is situated very near the pole, the circle that it describes in its diurnal motion will be entirely comprised within the field of the telescope, and evidently observations of the star's position, separated by four hours, for example, may take the place of those separated by twelve hours.

M. Lœwy gives formulæ, by whose aid two observations separated by an interval of four hours may be taken, and certain geometrical conditions indicated by his theory being complied with the whole effect of the instrumental errors may be eliminated. The co-ordinates of polars may be thus determined with a high degree of precision and quite independently of the level, azimuth, and collimation errors, as well as of the flexure and division errors.. (*Bull. Astron.*, August, 1885.)

Inaccuracies due to the use of the usual formulæ in the reduction of polar stars. A method of observing polars at any distance from the meridian.—"It is sometimes convenient to observe circumpolar stars when off the meridian; the ordinary reduction may then lead to erroneous results. M. Lœwy introduces a simple corrective term, by employing which the desired accuracy may be attained; the computation is facilitated by a numerical table annexed to the memoir." (*Bull. Astron.*, April, 1885.)

Star-charts.—In the *Vierteljahrsschrift* for 1884 Herr Palisa, in speaking of the publication of Dr. C. H. F. Peters's celestial charts, enters into some interesting details concerning the different processes employed in the construction of charts to be used in searching for minor planets. He speaks briefly of the very appreciable differences between Dr. Peters's estimates of magnitude and those of other observers when the stars under consideration are below the tenth magnitude. Thus Dr. Peters's eleventh magnitude stars are called twelfth and thirteenth magnitude by Herr Palisa. Herr Palisa made his estimates with a 12 inch telescope, Dr. Peters with a 13.5-inch. Herr Palisa adds that, after having used a 6 inch telescope at Pola for a long time, he found himself quite unable to estimate magnitudes with his 12-inch for as much as a year after beginning to use it, the differences of intensity between the tenth and thirteenth magnitudes seeming much less sensible than with the 6 inch. Dr. Peters's twenty charts that are already published are remarkably accurate, according to the careful revision of them made by Herr Palisa. (*Bull. Astron.*, March, 1885.)

Scintillation of stars.—The instrument employed daily by M. Montigny consists of a telescope of $0^{m}\cdot077$ aperture, which contains, in front of the focus, a circular piece of glass, capable of being turned more or less rapidly about an axis parallel to the optical axis of the telescope; the glass plate, when slightly inclined toward the optical axis, causes the luminous rays to deviate laterally, and when it is very rapidly revolved a luminous circumference appears interrupted by colored arcs, which correspond to the changes of color. The number of these arcs, which is determined by means of a micrometer especially adapted for the purpose, in which are two cross-threads comprising an aliquot part of the circumference, divided by the number of revolutions made by the plate in one second, gives the number of changes per second of the star's color.

Dufour seems to have been the first to make a regular series of observations of the changes of color in stars. Without any especial instrument, simply comparing the stars among themselves (as is often done for variable stars) Dufour came to the following conclusions:

(1) Red stars scintillate less than white stars.

(2) Excepting near the horizon the scintillation is proportional to the product obtained by multiplying the thickness of the air traversed by the luminous ray by the astronomical refraction of the altitude under consideration.

(3) Aside from the influence of color there are essential differences in the scintillation of different stars, which seem to depend upon the stars themselves.

The second law is important, as it permits of reducing all observations to the same zenith distance (the angle of 60° has been adopted).

M. Montigny has confirmed the results of the Swiss investigator by means of his scintillometer, and has further shown on what the scintillation of stars may depend. According to the work of Secchi, Huggins, and Miller, the stars are arranged in two great classes: White or blue stars, like Sirius, whose spectra show, in particular, hydrogen bands; yellow stars, like the sun, with spectra containing numerous fine lines (magnesium, sodium, &c.). In grouping his observations M. Montigny affirms that both for Dufour and himself:

"The stars whose spectra are characterized by dark bands and black lines scintillate less than stars whose spectra are composed of numerous fine lines and much less than those whose spectra present some principal rays."

Collecting his observations, M. Montigny has formed a *Catalogue de Scintillation des principales Étoiles* of the northern heavens.

The most original part of M Montigny's researches concerns the influence of the state of the atmosphere, of terrestrial magnetism, and of auroræ upon scintillation. Without entering into details, we would speak of the fact that the author has taken note of some of the characteristics of the luminous curve of the scintillometer; besides the intensity already defined, he now observes the aspect of the circular area, which appears sometimes regular (in clear weather), sometimes diffuse, curved or broken (during a rain); he also observes the different colors seen in the scintillometer, which are quite bright with a clear sky. M. Montigny's article closes as follows:

"That which exercises the most marked influence upon scintillation and most modifies its characteristics is the presence in the atmosphere of a greater or less quantity of water, whether disseminated in the form of vapor or falling in the form of rain or snow."

M. Montigny is of the opinion that the continued study of scintillation will furnish useful data for weather predictions. (*Bull. Astron.*, August, 1885.)

STELLAR PARALLAX.

Heliometer determinations of stellar parallax in the southern hemisphere. by David Gill and W. L. Elkin (*Mem. R. A. S.*, Vol. 48, Part I, 194 *pages*).—The heliometer has an aperture of 4 inches, and is fully described in the Dun Echt Publications, vol. II. The only modification made by Dr. Gill to this instrument,—which he had already employed in 1874 at Mauritius, at the time of the opposition of Juno, and in 1877 on his expedition to Ascension Island at the time of the opposition of Mars,—was in the rotation of the tube in its cradle.

The plan adopted may be explained in a few words. To refer the star that is being investigated to neighboring stars situated symmetrically with reference to the first star, near the major axis of the parallactic ellipse and differing little in magnitude; to reduce the brightness of the star to be investigated sufficiently for its image to be comparable with those of the comparison stars, by means of wire screens; finally, to substitute differential measures for absolute ones, grouping the successive observations in such a way as to obtain the distances of the principal star from the two other stars at the same instant, and consequently so as to obtain the relation of the difference of the distances to their sum without bringing in the absolute value of the scale.

It seems probable that systematic errors will be thus almost entirely avoided, especially if several observers combine their results. Let us consider the operations in detail, taking α Centauri as an example.

There was an unusual difficulty in this case, α Centauri being a double star. The screen employed reduced α_2 to the magnitude 8½, and rendered it impossible to distinguish α_1, but at the same time the measures of distances from stars fainter than 7·5 magnitude could not be so well made with a 4-inch heliometer. However, the 16 measures forming a *complete observation* are always made as follows: Each distance is measured twice for the sake of eliminating the constant error of the index, commencing with one of the stars, say α, then passing to β, turning the tube 180° in its cradle, taking β again and then α to complete the series. The sum and difference of the distances of α_2 Centauri from the first pair of stars chosen by Mr. Gill have the following parallactic factors:

$$\alpha + \beta,\ 0{\cdot}011\ \mathrm{R}\cos(\Theta - 96^\circ{\cdot}0),$$
$$\alpha - \beta,\ 1{\cdot}881\ \mathrm{R}\cos(\Theta - 347^\circ{\cdot}3);$$

R and Θ indicating the radius vector and the sun's longitude; the maxima and minima of the parallax for $\alpha-\beta$ occur upon March 7 and September 10.

We may pass over all that refers to the various corrections, the errors of the screw, refraction, the proper motion of α Centauri and aberration; it will suffice to say that in adopting for the sum of the distances a mean value derived from all the observations, the distances and their differences were reduced to a normal scale, and the only question now is whether these differences are not affected by systematic errors inherent in the observer. It might be, for example, that the observer would insensibly change his method of proceeding, thus introducing a term proportional to the time, but the personal error might also depend upon the hour angle if one observed to the east or to the west of the meridian, and at a greater or less distance from it, and in passing from one position to another a discontinuity might occur.* Mr. Gill used a reversing prism for Mars in 1877 for the sake of eliminating this last cause of error,† and he regrets not having continued its use, and avoiding thus, as he says, so much labor. The observations commenced July 5, 1881, and were continued regularly until April, 1882, when the existence of a systematic error depending upon the hour angle became evident. After this the conditions under which the observations were made were carefully noted, and it was possible to recall the conditions of the greater part of the preceding observations.

There are four series of observations for α Centauri—two by Mr. Gill, and two by Mr. Elkin—with four pairs of comparison stars. One of the first facts to be proved is the impossibility of treating the observations of each series as a whole. Mr Gill's diagrams prove this, as do also Mr. Elkin's numbers (giving his observations equal weights, Mr. Elkin found from his two series the values 0″·65 and 0″·55 instead of 0″·75). It seems best, then, to represent the influence of the systematic error by a trigonometric series depending upon the angle formed by the direction of the measures with the vertical, or more simply to admit for each position of the eye a constant error, varying slightly with the hour angle. Mr. Elkin proceeds thus, and his idea seems very rational. It is possible that Mr. Gill's second series of observations might be represented in the same way without introducing any hypothesis concerning the orbital motion of α Centauri.

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* It is known that observations of the nadir and measures of the declination of a star when between two threads are influenced by the position of the observer.

† Dr. Seeliger has also recently recommended the use of such a prism (*Bull. Astron.*, I, p. 450). We believe that one has been employed at the observatory of Leyden for a long time.

After having given an idea of the delicate questions which Mr. Gill and Mr. Elkin have had to solve, it remains to present the results obtained:

Star.	Observer.	Parallax.	Probable error.	Mag. of comp. stars.
		″	″	
α Centauri	Gill and Elkin	+ 0·75	± 0·01	7·6
Sirius	....do	+ 0·38	0·01	7·5
ε Indi	....do	+ 0·22	0·03	7½
Lacaille 9352	Gill	+ 0·28	0·02	7·6
o² Eridani	....do	+ 0·166	0·018	6·4
β Centauri	....do	− 0·018	0·019	7
ζ Toucanæ	Elkin	+ 0·06	0·019	7½
ε Eridani	....do	+ 0·14	0·020	6·4
Canopus	....do	+ 0·03	0·030	8

It is known that the observatory at the Cape will possess in two years from now a 7-inch heliometer, while Mr. Elkin has at his disposal, at Yale College, the most beautiful heliometer known to-day (6 inches aperture). It is quite possible that within ten years stellar astronomy may be enriched by discoveries of the greatest value. (O. Callandreau, in *Bull. Astron.*, January, 1885.)

Parallax of 40 *o² Eridani.*—Professor Hall publishes in No. 2682 of the *Astronomische Nachrichten* the results of observations made in 1883 and 1884 to determine the annual parallax of the star 40 o² Eridani. The principal star of this system has a proper motion of 4″ a year; and, at a distance of 82″, there is a double companion, which has the same proper motion, while nearly between them is a small star which does not move. Professor Hall finds for the parallax of 40 Eridani, $\pi = 0''\cdot223 \pm 0''\cdot0208$, a result rather smaller than might have been expected, but one which he considers worthy of considerable confidence.

Parallax of Σ 2398 (*P. M.* 2164).—Dr. Lamp, of Kiel, has investigated* the annual parallax of this double star, the components of which are 8·2 and 8·7 magnitude, according to W. Struve, and for the epoch 1832·17, distance 12″·420, and position-angle 134°·37. Later measures by Mädler, Dembowski, and Engelmann show a change of relative position, but of such small amount as to defeat any attempt at the determination of an orbit. The stars have a common proper motion of about $-0^{s}.1726$ in right ascension and $+1''.8955$ in declination, and this peculiarity led to the suspicion of a measurable parallax. The comparison stars used by Dr. Lamp were DM. +59°, 1913, and 1919, of 9·4 and 7·8 magnitude, respectively, and the mean result obtained is

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*Astron. Nachr., 2676.

$$\pi = 0''.34 \pm 0''.034$$

The position for 1885 is R. A. = $18^{h}41^{m}.5$; Decl. = + 59° 27′.

DOUBLE STARS.

The orbit of 61 *Cygni.*—Prof. C. F. W. Peters, of Kiel, has published in Nos. 2708–9 of the *Astronomische Nachrichten* an elaborate determination of the orbit of the double star 61 Cygni. This, as he remarks, had not hitherto been satisfactorly accomplished, although very numerous observations have been made, extending over an interval of more than one hundred and thirty years, principally on account of the peculiarity that the apparent path of the companion star is very nearly rectilinear in direction and uniform in amount, seeming to indicate that the apparent motion of the double star is common to both components, and that there is no perceptible motion of one with reference to the other. - - - The most recent investigation is that of Prof. O. Struve, published in the twenty-seventh volume of the *Memoirs of the Imperial Academy of St. Petersburg*, in 1880, which, founded on the observations (carefully cleared from systematic errors) made at Dorpat and Pulkowa in the fifty years from 1828 to 1878, represented them by a circular orbit. This, however, proceeded, as Professor Peters points out, on the inadmissible assumption that the angular velocity of the star, with regard to the center of the circle, was uniform. Before commencing the present investigation, he reduced all the available observations to a common epoch (the beginning of 1850). It soon appeared that it was not possible, on account of the very small curvature of the path, to obtain an elliptic orbit by the application of the ordinary methods. Professor Peters therefore determined in the first place the circular orbit which should best represent the observations, and proceeded afterwards to deduce an elliptical one. The eccentricity of this ellipse is 0·17, corresponding to an eccentric angle of 10°, and the semi-major axis 29″·48. The period of the companion star in the elliptic orbit thus calculated amounts to 782·6 years. If the path be accepted as thus calculated by Professor Peters, it becomes possible to determine an approximate value of the sum of the masses of the components. This he finds to be 0·826 or 0·266, in terms of the sun's mass according as 0″·37 or 0″·54 be taken as the parallax of the star. As a mean, therefore, the sum of the masses would be equal to about half the mass of the sun, whilst the mean distance of the two stars from each other would be about seventy times that of the earth, or two and one-third times that of Neptune, from the sun. It is not possible as yet to draw any conclusion with regard to the distribution of the whole mass between the components, or of the position of the center of gravity of the system. Peters has computed from his elements the following ephemeris:

Epoch	1885·0	1886·0	1887·0	1888·0
Position	119° 44′	120° 7′	120° 31′	120° 55′
Distance	20″·60	20″·71	20″·81	20″·92

Double star measures.—Nos. 2662–63 and 2677–78 of the *Astronomische Nachrichten* contain a series of measures of double stars made by Herr R. Engelmann during the years 1882–'84, preceded by a comparison of the differences between the observer's positions and distances of a number of stars, with those measured by Dembowski and Asaph Hall, and by other particulars bearing upon his own results. For several of the more interesting binaries the following epochs are given:

		°	″
Castor	1882·88	234·3	5·56
ζ Cancri	1884·28	67·0	0·94
ω Leonis	1884·23	91·4	0·66
ξ Ursæ Majoris	1884·41	249·6	1·92
γ Virginis	1883·07	155·6	5·22
42 Comæ Berenices	1882·93	192·1	0·56
ξ Bootis	1884·45	266·6	3·65

Another important series of double-star measures will be found in *Astronomische Nachrichten*, 2684–85. They are communicated by M. Perrotin, of the Nice Observatory, and are in continuation of the observations published in Nos. 2529 and 2559–60.

The series of micrometrical measures of double stars made at the Temple Observatory, Rugby, is continued in a "Fourth catalogue," published in volume 48 of the Memoirs of the Royal Astronomical Society.

A cause of systematic errors in measures of double stars.—M. Bigourdan (*Bull. Astron.*, I, 439) has recently pointed out a possible cause of systematic error in observing position angles. In the case of the Secretan equatorial of 0ᵐ·305 aperture of the Paris Observatory, he finds that the diffraction-rings surrounding the images of the brighter stars are discontinuous; so that when the objective is turned through 180° round its optical axis, as in observing east and west of the meridian, there is sufficient difference in the relative appearance of the components of a double star to cause systematic errors in the observed position-angles. And, in fact, from a series of experiments which M. Bigourdan has carried out with this instrument, he finds that there are considerable differences in the position-angles measured under the same conditions by the same observer, and within a few minutes of each other; so that the line joining the stars makes much the same angle with the line joining the eyes (always horizontal) in the two cases, one being east of the pier and the other west. M. Bigourdan points out that the errors cannot be eliminated by determination of personal errors from observations of artificial stars, since in these latter measures the stars alone are moved, and not the objective. It would be desirable, then, for observers who possess telescopes mounted in what is generally known as the "German" manner, and having such a defect as is described by M. Bigourdan, to have the tube of the telescope made movable round its optical axis, and to form each measure of position-angle from the mean of six made in six positions of the objective differing by 60°. As this would be practically impossible in the case of large instruments, M. Bigourdan suggests that observers, commencing a series of observations of double stars with telescopes of any considerable size, should turn the objective through 60° at the commencement of each year and re measure the same pairs as in the preceding year, and to continue this process until each pair has been measured in the six positions of the objective. (*Observatory*, March, 1885.)

Procyon.—In the *Vierteljahrsschrift* for 1884, Herr Seeliger reviews a work on *Procyon* by L. Struve. The work is a discussion of two series of observations of Procyon made at Pulkowa since 1851, and has appeared in the Memoirs of the Academy of Sciences at St. Petersburg. It is hard to tell whether these observations confirm Dr. Auwers' result (a circular orbit with a radius of 1″·00); they appear, on the whole, to indicate motions of a smaller amplitude.

β Cygni, Albireo.—The December number of *L'Astronomie* contains an article on this star in which a singular mistake occurs. β Cygni is Flamsteed's 6 Cygni, and M. Flammarion has been misled by this circumstance into identifying it with Bode's 6 Cygni, which latter star Professor Ball observed for annual parallax a year or two back, and found for it a value of about half a second. The star observed by Professor Ball is called 6 (B) Cygni, as being the second of the pair, 6 Cygni being a double star. (*Observatory.*)

VARIABLE, NEW, OR TEMPORARY STARS.

*Gore's catalogue of suspected variables.**—This catalogue may be regarded as complemental to the *Catalogue of Known Variable Stars*, by the same author, which was read before the Royal Irish Academy, January 28, 1884. It contains a list, including lettered numbers, of 745 stars in which some change of magnitude is suspected. The stars are tabulated in order of Right Ascension for the epoch 1880·0, and in separate columns are to be found particulars of the supposed change of magnitude and the authority on which the supposed change rests. In the notes and observations, by which the catalogue is followed, are given particulars of the history of each star, together with observations by the author of such stars as have received attention from him. The work is accompanied by a map showing the distribution of known and suspected variable stars.

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* A Catalogue of Suspected Variable Stars, with Notes and Observations. By J. E. Gore, M. R. I. A., F. R. A. S. A paper read befote the Royal Irish Academy, May 12, 1884.

A catalogue of this character forms a valuable working catalogue for the observer's use. By further observation suspected variation will in some cases be proved to be real, and the stars claim a place in a catalogue of known variables. A claim of this kind might indeed already be made in the case of Nos. 234, 455, and 635 of Mr. Gore's list. It may just be mentioned in passing that the place of No. 234. U Canis Minoris is incompletely given in the catalogue. Its more exact place for 1880 is R. A. $7^h 34^m 49^s$; Decl., $+8° 39'\cdot5$. There are other cases in which, though the period is as yet indeterminate, the fact of variation and its amount may be stated with some confidence. On the other hand, further observation may tend to throw a doubt on the suspicion of change in the case of other stars, and, as our author observes, "these must of course be removed from future catalogues." In the notes to No. 287, of his catalogue, α Hydræ, Mr. Gore quotes remarks by Sir John Herschel, Dr. Schmidt, and Dr. Gould to the effect that the supposed variability of this star may possibly be due to the influence of its ruddy color on the estimates of its brightness. Is it not possible that the effect of color on estimates of magnitude as respects different observers, or the same observer at different times, has hardly received so much attention as it deserves?

Large as is the number of stars included in Mr. Gore's catalogue, further additions might be made to it. Comparing it, for instance, with the tables of suspected variables, extracted from Mr. Chandler's unpublished catalogue, by Professor Pickering, and printed in his "Recent observations of variable stars" in the *Proceedings of the American Academy*, we find some thirty stars which are not included in Mr. Gore's list, and it is probable that others might be found in other quarters also. Indeed, the experience of most variable-star observers would probably suggest the view that cases of slight but distinctly recognizable light variation are relatively numerous.

A word in regard to No. 445 in the catalogue may possibly help to avert the chance of a little confusion in the future. This star was entered as U Bootis in Professor Schönfield's first catalogue of variable stars, but was rejected by him in his *Zweiter Catalog.* There is another star called U Bootis by Mr. Baxendell, in a paper in the *Manchester Lit. and Phil. Soc. Proceedings*, vol. 21, No. 11, the place of which, brought up to 1880, is R. A. $14^h 48^m 47^s$; Decl. $+18° 10'\cdot9$. This star has a period of 175·5 days, with a range of magnitude from about 13·5 at minimum to about 9·2 at maximum.

In conclusion we commend to the attention of all who are interested in the subject of variable stars a work the preparation of which must have entailed on the author a considerable amount of labor both as compiler and observer. (*Nature.*)

New variable in Vulpecula.—Mr. Edwin F. Sawyer has found[*] that the star D M. + 27°, 3890 is an interesting variable of the η Aquilæ type. From a preliminary reduction of the few observations thus far obtained a light curve has been formed, indicating strongly that the period will not vary much from 4½ days. The approximate limits of fluctuation are from 5·5 to 6·7 mag. The star is not in Argelander's *Uranometria Nova;* in *Heis* it is 6·0; in *Harvard Photometry* and the *Durchmusterung* 6·1. It is close to the star 32 Vulpeculæ, which has been suspected of variability. The position of the new variable for 1885·0 is: R. A. $20^h\ 45^m\ 19^s{\cdot}4$; Decl. + 27° 42′·3.

New variable in Cetus.—Mr. Sawyer also reports[†] a new variable in the constellation Cetus. The star was first observed on December 16, 1884, and noted as 7th magnitude. On January 10, 1885, it had decreased about a magnitude in brightness, and by February 10 it was barely visible in a field-glass, or it was of about 9·0 magnitude. An observation on March 5, by Mr. Sawyer and Mr. Chandler, with a 6-inch equatorial, made the star of 10½ magnitude. The position for 1855·0 is: R. A. $2^h\ 26^m\ 45^s$; Decl. — 13° 47′, and the star appears to be identical with S. DM. — 13°, 479. (*Astron Nachr.*, 2691.)

Variability of D M.—1°, 3553.—Dr. Valentiner, director of the Karlsruhe Observatory, has detected a slight variation, of about 0·5 magnitude, in the brightness of this star.

Variable in Ursa Minor.—Dr. Safarik has carefully observed a star given in Professor Pickering's second list of stars with remarkable spectra and there noted as variable; and he has found a mean period of 337 days with the epoch of max. 1883 August 1, epoch of min. 1883 November 26. The star is red, and gives a banded spectrum. Professor Safarik has designated it "R Ursæ Minoris," as the first variable known to him in the constellation Ursa Minor.

Observations of variable stars in 1884.—In the *Proc. Amer. Acad.*, vol. xx, p. 393, Professor Pickering gives a concise but clear view of the progress of observations, in Europe as well as in America, of this interesting class of objects during the year 1884. The following observers have co-operated with Harvard College in this important branch of astronomical research, viz, Backhouse and Knott in England; Dunér, Hartwig, Safarik, and Wilsing on the continent of Europe; Eadie, Hagen, Parkhurst, and Sawyer in the United States. Professor Pickering gives a list of about 150 variables which have been observed during the year, with the number of nights on which each star was observed by the astronomer whose designation is' attached to the number. It is hoped that observers of variable stars will continue to furnish accounts of their work during each year as soon as possible after its close. It is desirable that these accounts should be received at the Harvard College Observatory as early as February 1 of the following year. (*Observatory.*)

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[*] *Astron. Nachr.*, 2704.

[†] *Astron. Nachr.*, 2660.

The new star in the great nebula of Andromeda.—The astronomical event that attracted the most widespread attention in the year 1885, or perhaps in several years, was the telegraphic announcement, on August 31, by Dr. Hartwig, of the Dorpat Observatory, of his discovery, on the previous evening, of a new star in the great nebula of Andromeda.

The following account of this "*Nova* Andromedæ" is taken from a paper *read by Prof. Asaph Hall, at the meeting of the Philosophical Society of Washington, on February 13, 1886. Further details of the observations must be deferred to another report.

Dr. Hartwig "had suspected some change in the nebula as early as the 20th of August, but bad weather and a lack of instrumental means for making the matter certain deferred the announcement until the 31st. From the various estimates at that time the star was probably a little brighter than the 7th magnitude, or just below the limit of visibility to the naked eye. The announcement, of course, turned a host of observers to the new star, and many erroneous estimates and statements were made. Some observers estimated the brightness far too great, and several, on account of errors in the observations, announced that the new star was moving with an enormous velocity. It required the lapse of a few weeks to clear away and correct all this error.

"After Dr. Hartwig's announcement it appeared that several others had seen the new star, but for some reason, perhaps want of familiarity with this nebula and lack of confidence that a new star had really appeared, they did not make a public announcement. Thus the Baroness Podmaniczky, of Eastern Hungary, saw the new star on August 22 or 23 with a 3½-inch comet-seeker, and called the attention of a visitor to it, but they do not seem to have been certain that the object was new. This lady looked at the nebula on August 13, and did not see the new star. Mr. H. S. Moore, of McKinney, Tex., saw the new star on August 30. The circumstances indicate that this is a *bona fide* observation. A really independent discovery was made by Freiherr von Spiessen, of Winkel, in Rheingau, who found the new star on August 30. - - - Mr. Isaac W. Ward, of Belfast, Ireland, claims that he saw the new star on August 19, when it was of the 9½ magnitude. Finally, Prof. Ludoric Grelly, of Rouen, says that he saw the new star on the 17th of August, and showed it to several friends and visitors. On the other hand, Mr. Tempel, of Florence, Italy, who has done much work on nebulæ, and who is well acquainted with the great nebula of Andromeda, says that he is confident that there was no star in the place of the new one which was easily visible in his telescope on the 15th and 16th of August. This testimony is important and serves to fix the time of the appearance of the *nova*, or at least the time it became an easy object in telescopes, within very narrow limits. This time must have been between the 16th and 20th of August, 1885. It is probable that the star increased rapidly in brightness, since on August 31 it was of the 7th magnitude. It never,

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* See, also, *Amer. J. Sci.*, 3 ser., vol. 31, p. 299–303.

I think, became much brighter, though statements were made early in September that it was of the 2d or 3d magnitude and easily visible to the naked eye. Its diminution of brightness began about August 31, and has gone on pretty steadily until the present time [February, 1886]. - - -

"At first the position of the new star was confounded with that of the bright point of the nebula, and as this mistake added interest to the discovery it was some time before it could be generally corrected. - - - The assumption of any intimate physical connection of the new star with the nebula has been given up by Vogel, of Potsdam, and Hasselberg, of Pulkowa, who have examined its spectrum. Within the limits of this nebula there can be counted from fifteen hundred to two thousand telescopic stars, and one of these has proved to belong to the class of temporary stars, so called, of which we have records of from 20 to 30. What causes these stars suddenly to flame out and then to fade gradually away we do not know, and, so far as I know, there is hardly a plausible theory.

"I first saw the new star on September 6, when its magnitude seemed to me 7½, and the star had a decidedly ruddy tinge. This color lasted but a few weeks, and as the star grew fainter it became of a white color. My observations have been continued until February 7 of the present year, and probably the star will be visible in the 26-inch refractor after the present moon has passed. It is now very near the limit of visibility in our telescope, or of nearly the 16th magnitude. The passage from the 7th magnitude to the 16th corresponds to a very great change of brightness, since it is the passage from the limit of visibility to the naked eye to that in a 26-inch telescope. Several hypotheses were proposed to account for this wonderful star, and one that seemed to me quite ingenious is that of Mr. Monck, of Ireland, who assumed that this star is one of the swiftly-moving ones that in rushing through the nebula had been set on fire, like a meteor in our atmosphere. Led by some such suggestion, and also by that of Professor Peters that it would be interesting to test the parallax of such a star, on September 29 I began some measures of the new star by referring it by means of polar co-ordinates to a known star of the 11th magnitude, distant from it a little less than 2′. - - - I do not think my measures show any proof of a parallax, though they indicate, perhaps, a diminution of the distance, and even this may be sufficiently accounted for by variations in the light and color of the new star, since such variations would be likely to affect the measures. - - -

"The great nebula of Andromeda is easily visible to the naked eye, and doubtless it was known to the astronomers of very ancient times. Those astronomers watched the heavens with unaided vision much more carefully than do modern astronomers, and they were far better acquainted with the constellations. The old astronomers had a theory that this nebula was variable both in form and brightness. They had poor means of judging of its form, but it is possible that their estimate of brightness may be more trustworthy, and that our new star may be an old variable which has appeared before, causing the nebula apparently to vary in brightness." - - -

The new star near χ' Orionis.—Mr. J. E. Gore, of Beltra, Ballysadare, Ireland, discovered on December 13 a reddish star of about the 6th magnitude, following χ' (54) Orionis by about a minute and a half of time, nearly in the same parallel. Drs. Copeland and Becker observed it at Dun Echt on the 16th, and found it to be of the 6½ magnitude and of an orange-red color. They remark: "It has a very beautiful banded spectrum of the third type, seven dark bands being readily distinguished with the prism; the bright intervals seem full of bright lines, especially in the green and blue." M. C. Wolf has also examined the spectrum of this remarkable star at the Paris Observatory; he finds it to be of a totally different character from those of the stars which underwent such great outbursts of brilliancy in the constellations Corona and Cygnus in the years 1866 and 1876, respectively, and presenting, in fact, a great similarity to the spectrum of that extraordinarily variable star known as Mira or *o* Ceti.

SPECTRA OF STARS.

Stars with spectra of the third type.—"Professor Dunér has published an important catalogue of stars having banded spectra. Following Professor Vogel's classification, he prefers to regard the spectra with bands fading away towards the violet as a subdivision of the same type as those in which the bands fade away towards the red, rather than, with Secchi, to make them into a separate class. Dunér's type III *a*, therefore, corresponds to Secchi's third type, and his III *b* to Secchi's fourth type. Professor Dunér's purpose in forming this catalogue is to supply the means for future observers to detect changes in these spectra, should any such occur, for, as he points out, these stars are probably in a very advanced state of development, and we may therefore, perhaps, hope to discover some day changes in their spectra, which, carefully studied, may lead to important results as to the nature of suns. They are the more interesting, also, because variable stars of long period usually belong to this class.

"With this view Professor Dunér has carefully examined all the known objects of this type which are visible in his latitude, and for which the optical means at his command were sufficient, and he has catalogued 297 stars of type III *a*—that is, with bands shading off towards the red—and 55 of type III *b*, with bands shading off in the opposite direction. An important section follows, giving a list of stars which different astronomers have regarded as belonging to the third class, but which Dunér cannot so classify. Only in a very few instances, however, is there any good reason to suspect a change in the spectrum. In the great majority Secchi, whose observations supply most of these cases of discrepancy, had himself at one time or another registered the star as being of the second type, *i. e.*, without bands, or else had especially remarked on the extreme feebleness of the bands which he thought he saw. There are, however, three stars observed by D'Arrest for which the evidence of change seems stronger, viz, Lal. 24034, D M. + 60°, 1461, and D M. + 36°, 2772. Professor Dunér has also failed to find Schjellerup 249, which is, perhaps, a long period variable, and he draws special attention to R Andromedæ, a star the spectrum of which, though of type III *a*, presents some very marked peculiarities. Great care has been taken in the determination of the position of the bands in the different spectra. It is clear, as many spectroscopists have already observed, that the bands of type III *a* occupy the same positions in all the spectra of the type, and the same is true for the bands of type III *b*. With regard to the former class, the sharp dark edges on the more refrangible sides of the bands generally coincide with strong metallic lines. Thus one of the most prominent bands is terminated by the *b* lines of magnesium. The nature of the connection between the bands and these metallic lines is not at all clear at present, the symmetrical arrangement of the bands seeming to suggest that they are due to some one substance rather than to several. The three principal bands of the spectra of the other type Professor Dunér considers to be unmistakably those of a carbon compound, and to correspond to the bright bands so familiar in the spectra of comets. The determinations of the wave-lengths of the bands in spectra of this type are necessarily not quite so accurate as those of the bands in spectra of type III *a*, but if Professor Dunér's measures are accepted, this most important correspondence may be considered fully established. But apart from the value of these measures, Professor Dunér's catalogue, with the full and clear descriptions he has appended to every star, will be of the utmost service to future observers of these interesting and beautiful objects." (*Observatory*, November, 1885.)

Bright lines in stellar spectra.—"Mr. O. T. Sherman has continued his researches on the spectra of γ Cassiopeiæ and β Lyræ, and announces in the *American Journal of Science* for December the discovery of no fewer than fifteen bright lines in the spectrum of the former star and seventeen in that of the latter. The lines seen in γ Cassiopeiæ are as follows: Hα, λ 6356, 6160, D_3, λ 5840, 5557·5, 5422, 5309·8, 5167·5, 4990, Hβ, λ 4623, Hγ, λ 4180, and Hδ, bright lines; and λ 6280, 5760, 5020, 4920, 4673·5, and 3993. dark lines. The bright lines agree closely in position with the principal lines observed by Professor Young in the spectrum of the chromosphere. Mr. Sherman has also examined a large number of other stars, and '*in each case* many or few bright lines have been seen, lines, so far as I know, formerly unsuspected.' It is clear, if Mr. Sherman's observations can be satisfactorily confirmed, that we have here a most important discovery; but, looking to the fact that these stars have probably been frequently observed by experienced spectroscopists without any bright lines being detected in them, whilst a false appearance of bright lines is readily produced in stellar spectra under certain circumstances, it would appear hazardous to accept Mr. Sherman's result without further evidence." (*Nature*, December 17, 1885.)

Periodic variations in the spectrum of β Lyræ.—Herr von Gothard reported last year (*Bull. Astron.*, I, p. 211) the appearance of the brilliant lines, which had not been seen for some time, in the spectra of γ Cassiopeiæ and β Lyræ. During the year he has been able to prove the periodic variability of the line D_3 in the spectrum of β Lyræ. The period seems to be very short, and is probably about 7 days. The hydrogen lines vary also, but their variation is less pronounced. The spectrum of γ Cassiopeiæ also offers some indications of analogous variations.

PROPER MOTION OF STARS.

Stars in rapid motion.—The small value of the parallax of 40 o^2 Eridani (*Science*, vi, 358), combined with its large proper motion (4″·10), brings it into prominence as the third or fourth of the stars moving rapidly across our line of sight. Since a list of these stars seldom appears in works on popular astronomy, we give below the proper motions μ, the parallaxes π, and the resulting velocities v, in miles per second across our line of sight, of the eight stars which head the list in the order of velocities. The method of deriving the velocities is of course very simple. If a star's annual proper motion equals its parallax, it moves across our line of sight each year a distance equal to the semi-major axis of the earth's orbit. (How much it moves to or from us can only be told by the spectroscope.) Therefore, since this motion increases directly as μ, and inversely as π, we have for the annual motion across the line of sight—

$$vt = a\frac{\mu}{\pi}$$

or, calling a 92.5 million miles, and t the number of seconds in a year, we have for the volocity in miles per second—

$$v = 2{\cdot}93\frac{\mu}{\pi}$$

Of course, the proper motions below are much more accurately known than the parallaxes, and where the latter are small the values of v are correspondingly uncertain. The authorities for the adopted values of π are given in the column following them. In the case of 40 o^2 Eridani, we have weighted Gill and Hall 2 and 1 respectively, as the former determination was made under much the more favorable conditions, and rests upon two comparison stars. The latest values of Hall and Ball for 61 Cygni are practically identical. The probable errors of all the values of π are generally less than 0″·02.

Star's name.	μ	Parallax.		v
		π	Authority.	
Groombridge 1830	7″·05	0″·09	Brünnow	230
Lacaille 9352	6 ·96	0 ·285	Gill	71
40σ^2 Eridani	4 ·10	0 ·185	Gill and Hall	65
ε Eridani	3 ·10	0 ·14	Elkin	65
ε Indi	4 ·68	0 ·22	Gill and Elkin	62
Lalande 21258	4 ·40	0 ·27	Auwers	48
61 Cygni	5 ·23	0 ·48	Hall and Ball	32
Lalande 21185	4 ·75	0 ·50	Winnecke	25

The first will be recognized as Newcomb's "runaway star," so graphically described in his Popular Astronomy; but it will be seen that the others have velocities which are at least comparable with that of Groombridge 1830, and indicate momenta that represent vast amounts of energy. The discovery of huge suns like our own rushing through space with these great velocities is a matter of more than usual interest just now, from the fact that Mr. Denning's claimed discovery of fixed meteor-radiants has raised the question as to the possible existence of broad swiftly flying streams of meteorites in interstellar space, moving with velocities entirely beyond the control of our sun, and so broad that it takes the solar system some years to pass through them. (An annual parallax of 1° in a meteor-radiant corresponds to a velocity of over 1,000 miles per second for the meteor stream.) The idea of such streams moving with such velocities is a startling one, and, if shown to be true, gives a very vivid idea of the forces acting, or which have acted, in stellar space. It seems at first highly improbable that such can be the case, but with the hard facts of Groombridge 1830 and these other swiftly flying suns staring us in the face, the idea is worth considering, at any rate. If these suns are the products of condensation due to central attraction, so that the luminous energy by which they reveal themselves to us was once energy of translation, it is no violent assumption to suppose that some of their constituent parts were once moving with much greater velocities than that of the present whole. In fact, the man who should claim as a possibility that space contains broad belts of small particles moving with velocities which are the resultant of all the forces acting on them since primeval chaos, and which have not yet been gathered into the control of any of the stellar systems among which they are sweeping, would find much to confirm his ideas in these giant swiftly flying suns. The question is certainly of sufficient interest and importance to call for a thorough overhauling of the present methods of determining meteor-radiants, for probably most astronomers would to-day be disposed to deny *in toto* the existence of the greater part of these so-called radiant-points." (H. M. Paul, *Science*, November 27, 1885.)

Star with large proper motion in Sculptor.—Dr. Gould has noticed a case of large proper motion in a star in Sculptor, barely of the 8th magnitude (R. A. $=23^h\ 58^m$, Decl. $= -37^\circ\ 58'$). It appears to have a proper motion of $+\ 0^s\!\cdot\!482$ and $-\ 2''\!\cdot\!45$, or $6''\!\cdot\!21$ in the arc of a great circle. This motion is only less than that of Groombridge 1830 ($7''\!\cdot\!03$), and that of Lacaille 9352 ($6''\!\cdot\!96$), which precedes the star in question by 1^h and is upon nearly the same parallel. The star is numbered 1584 in Hour XXIII of the Cordoba Zone-Catalogue.

Proper motion of Lalande 16616.—Professor Frisby has found* a proper motion of $-0^s\!\cdot\!00920 \pm 0^s\!\cdot\!0013$, in right ascension and $-0''\!\cdot\!3619 \pm 0''\!\cdot\!0048$ in declination for this star, from observations of Lalande, Argelander, Robinson, and Washington transit-circle observations in the years 1881 and 1882.

A large proper motion has been detected by Herr Berberich in the star Weisse X 1021; and Professor Porter has called attention to proper motions in the stars Lalande 20959 and 24423.

Proper motions in the Pleiades.—Professor Pritchard has published in the forty eighth volume of the *Memoirs of the Royal Astronomical Society* a paper of some 50 pages, "On the relative proper motions of forty stars in the Pleiades, determined from micrometric and meridional observations."

Motions of stars in the line of sight.—"For the past ten years the Royal Observatory of Greenwich has been assiduously observing the spectra of more than 50 of the brightest stars, for the purpose of determining the velocity of their motions toward or from the earth in the 'line of sight'—the line joining the earth and star. The reports of the astronomer royal have given the annual results, but no general exhibition of the present state of the question has been made until lately, when Mr. Maunder, the observer, has collected them in an interesting paper in the *Observatory.* Mr. Maunder points out, in the first place, that the conclusions which are drawn are worthy of confidence in spite of the extremely small displacements of the spectral lines upon which they depend. The entirely independent researches at Greenwich and those of Dr. Huggins and Dr. Vogel mutually confirm each other; and, moreover, if the method is applied to the measurement of the difference between the velocity of approach of the two limbs (edges) of the sun or Jupiter, the results are consistent with what we know of the rotation-times of these two bodies. We can compute exactly how fast one limb of the sun is approaching us, and how fast the opposite limb is moving away; and these same quantities can be determined by the spectroscopic methods with substantially the same results. Hence the spectroscopic determinations of the velocity of a body in the line of sight may be fairly said to belong to exact astronomy. The directions and the velocities for some fifty stars have been thus determined at Greenwich by measures extending over several years. Velocities of thirty to forty miles per second are not uncommon. A velocity of less than ten miles corresponds to such a small displacement that its determination becomes difficult. The case of Sirius is an interesting one, from the fact that its motion has changed from a recession of 21 miles per second in 1875–'76 to an approach of 21 miles per second in 1884. The proof is very clear, the separate years giving:

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* *Astron Nachr.*, 2683.

1876	21 miles per second;	recession
1877	23 miles per second;	recession
1879	15 miles per second;	recession
1880	11 miles per second;	recession
1881	2 miles per second;	recession
1882	5 miles per second;	approach
1883	19 miles per second;	approach
1884	21 miles per second;	approach

"But the interest of this research is not in accumulating data as to the motion of individual stars, however important this may be. The real point is, what light does this method throw upon the theory that the sun, with the whole solar system, is moving toward the constellation Hercules at a rate of some 590,000,000 miles per annum? Attempts have been previously made to show that the spectroscopic data confirm the theory, which, indeed, has a fairly firm basis on other grounds. Mr. Maunder declares that these attempts are premature, and that the spectroscopic data are as yet insufficient. So far as they go, they rather indicate a motion toward α Aquarii. 'Still, if the sun's speed be small compared with the average speed of the stars observed, there is nothing in the observations incompatible with the generally accepted direction.' Mr. Maunder points out the fact that Greenwich Observatory is the only observatory prosecuting these researches, which demand a refined spectroscope, a large telescope, and a very clear and quiet atmosphere—conditions all lacking at the Royal Observatory. He expresses the hope that the observatories of Nice and Melbourne may devote their large telescopes to this work. In America we have several large refractors admirably suited for the work, and it is to be hoped that some of them may be exclusively devoted to it." (*Nation*, June 11, 1885.)

PHOTOMETRY.

Standards of stellar magnitudes.—The third report of the American committee on standards of stellar magnitudes states that the zones following the twenty-four selected equatorial stars have received a second careful revision with the Princeton 23-inch, which should make them include all stars down to about 16·0 magnitude, and that a revision will probably be made with the Washington 26-inch. Four of the charts have been distributed to all observatories having large telescopes, with requests for all visible additions which will furnish comparisons of the penetrating power of different kinds of telescopes. Certain selected standards in each zone, about 0·5 magnitude apart, have been measured at the Harvard College Observatory with photometer I, and the two brightest, if not too faint, with the meridian-photometer. A catalogue of these selected standards in the twenty-four zones, giving the positions and provisional magnitudes, is published, and also a table of twenty-one close circumpolars ranging in magnitude from 2·2 to 15·7. (*Science*, "Astron. Notes.")

Harvard Photometry.—M. Th. Wolff, of the Bonn Observatory, reviews at considerable length (40 pages) the last volume of the *Annals of the Harvard College Observatory*, which contains the photometric investigations of Professor Pickering and his assistants. M. Wolff has submitted the work of the American astronomers to a minute examination and has established very interesting relations between the results of the Harvard College meridian photometer and the results of his own work with a Zoellner photometer. With the latter photometer the observed star is compared with an artificial star, while with the meridian photometer the observed star is compared with Polaris. The two images, one formed by the ordinary and the other by the extraordinary ray of the respective stars, meet in a double image prism and are observed across a Nicol prism. As a check on the work, Polaris was often compared with itself. The magnitudes obtained vary from 1·4 to 2·7, the mean of 630 determinations being 1·90 instead of 2·0, the magnitude adopted for Polaris. This discerpancy is inexplicable. The mean of the differences between Professor Pickering's catalogue and M. Wolff's two catalogues is ± 0·11 magnitudes, or for the logarithm of the intensity ± 0·044. It is a matter for regret that Professor Pickering did not publish the relative intensities that were the direct results of observation, but preferred to give the magnitudes computed by Pogson's formula, with the constant 0·4. M. Wolff very justly remarks that this constant, determined by the observation of telescopic stars, cannot apply to stars of the first six classes; he finds that to establish an agreement with Argelander this constant must be reduced to 0·37, or even to 0·33. Professor Pickering has endeavored to make his work agree with Argelander's by adding + 0·27 to all his results; but this reduction has altered the discrepancies without doing away with them. By reducing the numbers published by Professor Pickering back to the logarithms of intensity from which they were derived, and comparing these results with his own, M. Wolff finds the following mean result:

$$W - W_0 = 0{\cdot}84\ (P - P_0),$$

which would indicate the existence of an unexpectedly large personal equation. (*Bull. Astron.*, August, 1885.)

The Oxford Uranometria.[*]—"The form of photometer Professor Pritchard has adopted is now too generally known to require description. It possesses the high merits of simplicity of construction and use and freedom from liability of derangement. In addition to these qualities, Professor Pritchard has been careful, in his use of it, to free it from systematic errors arising from the continual use of the same part of the wedge for the same star. Not only has the coefficient of absorption been separately determined for every point of the wedge, but the system of observation adopted has involved the employment of four different apertures of telescope in conjunction with two wedges, and by two different observers. Each determination of magnitude, therefore, is the mean of twenty observations, a set of five observations being taken with each of what are practically four different instruments. When to this is added the circumstance that the determinations of magnitude are differential only, and that therefore three complete sets of extinctions were made of the standard star Polaris every evening, and that for the better determination of the atmospheric absorption and of the magnitudes of southern stars a considerable portion of the observations were made at Cairo, it becomes evident that the work of determining the magnitudes of nearly 3,000 stars which Professor Pritchard, with his assistants, Messrs. Plummer and Jenkins, has here accomplished, is one of very considerable dimensions indeed.

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[*] Astronomical observations made at the University Observatory, Oxford, under the direction of C. Pritchard, D. D., F. R. S., F. G. S., F. R. A. S., Savilian Professor of Astronomy in Oxford.—No. II. *Uranometria Nova Oxoniensis.* A photometric determination of the magnitudes of all stars visible to the naked eye from the pole to ten degrees south of the equator. Oxford: At the Clarendon Press.

"The convenience of Professor Pritchard's photometer, and the magnitude of the work he has undertaken with it, stand beyond dispute; but the delicacy of the wedge is another question. And here we are met with the circumstance that the observations seem to show little or no evidence of any effect due to changes in the sensitiveness of the observer's eye, to personality, to moonlight, and only to a small extent to color in the star observed; and this unexpected and remarkable result has called forth not a little criticism, for as the construction of this photometer is not such as to lead us to expect that it would be wholly free from errors of these kinds, a doubt seems to be thrown upon its sensitiveness. Professor Pritchard has replied to these criticisms in the frankest manner, showing that they had not escaped his notice; but whether he has quite refuted them is a point which we may, however, well think still *sub judice*. Probably the wise arrangement by which an ordinary evening's work is confined to three hours or less will largely explain the absence of deviations due to the first-named cause, and with regard to the third it is most likely that observations on bright moonlight nights or of stars near the moon have been generally avoided. The observations of Polaris which Professor Pritchard has brought forward in this connection scarcely touch the real difficulty. The *substantial* accuracy of the Oxford star magnitudes is, however, shown by the close agreement which they bear to determinations made at other observatories and by widely different methods, and it is possible that the future may show that the exceedingly small deviations of the individual observations are a true index of the minuteness of their errors." (E. W. Maunder, *Observatory*.)

Photometric observations at Potsdam.—Professor Safarik has made quite an extended analysis of Dr. Müller's *Photometric Researches*, which have appeared in the Publications of the Potsdam Observatory (1883). These researches have been carried on since 1877, their object being the study of atmospheric extinction and of the relative brightness of the planets and of a series of variable stars. The instrument employed by Dr. Müller is a Zoellner photometer, with an aperture of 0·037 meter. The aperture of the objective may be reduced by diaphragms; it seems, however, that the effect of the diaphragms does not always correspond to the expectations based upon the diminution of the aperture. Professor Safarik thinks the cause of this disagreement must be sought in the employment of a magnifying power that is much too low, so that the resulting ocular ring is larger than the aperture of the pupil of the eye. This photometer is not suitable for colorimetric researches.

Dr. Müller's observations relative to atmospheric extinction have consisted in comparing the five following stars, which can be observed at widely different zenith distances, with Polaris: α Cygni, η Ursæ Majoris, δ Persei, α Aurigæ, and α Tauri. Curves have been traced representing the logarithmic intensities as a function of the zenith distance. These curves show no indication of variability for the six stars in question, unless it be in the case of α Tauri. It is a curious fact that the white stars do not become quite as much fainter in the neighborhood of the horizon as the red stars do. This is probably due to some physiological cause. We give here some of the values finally adopted for reduction to the zenith (the numbers given are the logarithms):

Z. D.	Reduction.	Z. D.	Reduction.
10°	0·0004	75°	0·2596
20	0·0037	80	0·3908
30	0·0112	82	0·4718
40	0·0244	84	0·5959
50	0·0482	86	0·8164
60	0·0920	87	0·9929
70	0·1798	88	1·2409

Four units in the first decimal place being equivalent to one magnitude, we see that for Z. D.=80°, 86°, 88°, the reduction represents 1, 2, and 3 magnitudes respectively. Dr. Müller's curves offer as a whole a very satisfactory agreement with those of Seidel, in spite of the difference of climate between Potsdam and Munich, and in spite of the different processes employed in the two observations. Dr. Müller finds the mean value 0·8250 for the fraction of a star's light that comes through our atmosphere when the star is seen in the zenith; the atmosphere then absorbs a little more than $\frac{1}{6}$ of the light. The coefficient of extinction should thus be 0·8250 (0·21 magnitude); Seidel found it to be equal to 0·100 (0·25 magnitude). Professor Safarik speaks in conclusion of the recent work done by Wolf, and Langley." (*Bull. Astron.*, September, 1885.)

Photometry of the Pleiades.—"A valuable memoir (*Mémoires de l'Académie Impériale des Sciences de St. Petersbourg*, VII *série, tome* XXXII, *No.* 6), by Herr Ed. Lindemann, of Pulkowa, 'On the magnitudes of Bessel's stars in the Pleiades,' has recently reached us. A special point of interest lies in the fact that Professors Pickering and Pritchard have likewise determined the brightness of many of these stars with their respective photometers, each assuming the magnitude of Merope, to which the other stars of the group are referred, as 4·22. Herr Lindemann has also adopted the same magnitude for Merope, which he has used as his standard star. He also employed, as reference stars, Celæno and Anon. 32, the magnitudes of which he had determined to be 5·27 and 6·51, respectively. The stars, fifty-two in number, were each observed on two separate nights, only one star of the fifty-three observed by Bessel proving too faint for Herr Lindemann's telescope of five inches aperture. Comparing his own results with those of Professors Pickering and Pritchard, Herr Lindemann finds, on the whole, a very gratifying agreement; twenty-five stars observed by Professor Pickering showing a mean excess over the Pulkowa observations of 0·04 of a magnitude, and thirty-three stars observed by Professor Pritchard giving a mean excess of 0·05. Professor Pritchard's later observations give a yet smaller difference, viz, 0·01 of a magnitude. When it is remembered that the three photometers employed—Herr Lindemann using a Zoellner photometer—differed entirely in principle, construction, and method of employment, this close agreement would seem to indicate that each may be relied upon with very considerable confidence when the differences of stellar magnitude determined by their means are not very great. The stars Nos. 1, 4, 21, 31, and 33 would appear to be variable, and possibly two others likewise. Pogson's scale has been employed for the conversion of the logarithm of the light of the star into magnitude." (*Nature*, December 17, 1885.)

Professor Pickering in the *Proceedings of the American Society for Psychical Research* has tried to find out from the discussion of a large number of observations, whether the knowledge of a catalogue magnitude of a star on the part of a recorder exerts through the medium of "thought-transference" any influence upon the independence of the observer's estimate. His conclusion is in the negative.

ASTRONOMICAL PHOTOGRAPHY.

Photographic map of the heavens made, with the aid of two objectives, by Paul and Prosper Henry.—"In their first attempts at stellar photography the Messrs. Henry had especially in view the discovery of some rapid means for the construction of their ecliptic charts. As these first attempts gave excellent results, M. Mouchez had apparatus constructed that was especially adapted to stellar photography; the mechanical part is due to Gautier, the optical part being the work of the Messrs. Henry. This new instrument consists of two telescopes in juxtaposition, each having about the same focal length (3·60 meters), and apertures of 0·24 meter and 0·34 meter respectively. The latter telescope, which serves for the photography, is rendered achromatic for chemical rays; the other telescope is used as a pointer in keeping the image of the star at exactly the same point of the photographic plate for the requisite length of time; the field is about 3°. The Messrs. Henry have recently succeeded in obtaining, with an exposure of one hour, a very beautiful proof, which has been presented to the Academy by M. Mouchez. It represents an expanse of about 5° and shows 2,790 stars between the 5th and 14th magnitudes. Such a chart as this one, obtained in one hour, would have certainly required a number of months to prepare by ordinary methods." (*Bull. Astron.*, June, 1885.)

Photographic charts of regions of the Milky Way, by Paul and Prosper Henry, of the Paris Observatory.—"About 5,000 stars between the 6th and 15th magnitudes can be counted on the plate presented to the Academy by M. Mouchez. The plate shows an area of 2° 15′ of right ascension by 3° of declination, and was obtained by the new photographic apparatus described in vol. II, p. 289, of the *Bulletin Astronomique.* In order to avoid confounding flaws in the plate with stars three successive exposures of an hour each were made, the telescope being moved 5″ each time, so that each star is represented by three points forming an equilateral triangle, the sides being 5″ in length.

"M. Mouchez estimates that 6,000 similar plates would be required to represent the whole sky, and that these would form 1,500 charts of the size of the ecliptic charts of the Paris Observatory." (*Bull. Astron.*, August, 1885.)

Photograph of the star cluster of Perseus.—"During September, 1884, Dr. Lohse took advantage of exceptionally clear nights to attempt some star photographs, using the 11-inch refractor belonging to the Potsdam Observatory. An exposure of 45 minutes generally sufficed for obtaining photographs of stars as faint as 10th to 11th magnitude. The finder of the telescope was employed as a pointer in correcting the errors due to the driving clock; but it would have been better to point the telescope directly by means of an eye-piece inserted in the photographic chamber. Such an arrangement has been invented by Mr. Common. Two successive positions of the most brilliant star of the group have always been reproduced for the purpose of fixing upon the plate the position of the apparent parallel. The sensitive plates were furnished by Wratten and Wainwright of London. The images were developed by a concentrated solution of oxalate of iron, to which was added potassium bromide. The development can be hastened by plunging the plates for about two minutes into a very weak solution of nitrate of chrysaniline.

Dr. Lohse has succeeded in this way in photographing a certain number of star clusters, and in particular the cluster χ Persei, which Dr. H. C. Vogel studied in 1878. A negative obtained September 24 served to identify the stars by micrometer measures, and one obtained September 26 served to determine the magnitudes. The plates showed 57 stars between the 6th and 11th magnitudes. It is certain that the photographic determination of the relative positions of so many stars represents a very considerable economy of time, and also guards against personal errors. As for the errors of the photograph, they can always be detected by the simultaneous reproduction of a squared reticle. Five successive exposures of 1^m, 4^m, 9^m, 16^m, 25^m, respectively, were made for the purpose of determining the magnitudes, the telescope being each time moved in declination. Five series of images, each more numerous than the last, were thus obtained. The photo-chemical effect is known to be proportional to the intensity of the light and to the time of the exposure; in cases of equally distinct images, therefore, the brightness of the stars must be inversely proportional to the time of exposure. Dr. Lohse has proceeded upon this principle in determining the relative magnitudes of the stars in the cluster of χ Persei, employing Dr. Vogel's actinometric data. (It seems that the photographic intensities of two successive magnitudes are in the ratio of 1 : 3, while the ratio of intensities as seen with the eye is that of 1 : 2·5.) Photographic magnitudes generally agree well enough with optical magnitudes; still there are some exceptions: thus a red star called 8·5 by Dr. Vogel is marked 10·5 by Dr. Lohse. It would be interesting to apply the same process to the actinometric study of variable stars.

We must not neglect to speak here of the fact that MM. Henry have obtained a very beautiful photograph of the star cluster of Perseus at the Paris Observatory. They succeeded in locating 509 stars between the 6th and 13th magnitudes included within 1° of right ascension and 1°·5 of declination." (*Bull. Astron.*, March, 1885.)

Stellar photography at Harvard College Observatory.—By the aid of the Bache fund an important investigation has been undertaken in stellar photography. It is found that stars as faint as the 6th magnitude, in any part of the sky, can be readily photographed, even without clockwork; while near the pole, where the diurnal motion is slower, stars as faint as the 14th magnitude may be photographed in like manner. These results have much value as a means of determining the relative positions and brightness of different stars. Charts of regions five degrees square can also be photographically prepared and enlarged by photolithography to the scale of the maps drawn by Chacornac and Peters. The spectra of stars have all been photographed with much success. Stars as faint as the 8th magnitude give photographic spectra in the paper prints, from which the lines can be distinctly seen. Mr. W. H. Pickering has rendered important aid in this investigation. A part of his researches upon the possibility of photographing the solar corona, except during an eclipse, was conducted at the Observatory and the results published in *Science*.

The first stellar photographs ever taken were those of α Lyræ, by the elder Bond, at the Harvard Observatory, in 1850. In 1857 his son carried similar investigations much further. At first, however, they were unable to obtain clear images of stars of the 2d magnitude, while now it is possible to print those of the 14th, or, in other words, to transfer to paper an image produced by an object only a hundred-thousandth part as bright as formerly. Professor Pickering's researches have been carried on with an instrument that he has devised himself, in which a Voigtlander portrait lens of 8 inches aperture and 44 inches focus has been reground and mounted equatorially. It is driven by clockwork, having a Bond spring-governor, controlled electrically by a sidereal clock.

We have already referred (under Nebulæ) to the fact that Professor Pickering has found upon one of his plates a trace of the nebulæ around Maia, discovered by the Henrys at Paris.

Stellar photography at the Cape Observatory.—Upwards of one hundred successful photographs have been obtained towards the completion of a photographic Durchmusterung of the southern heavens. Each photograph covers a square of 6° on the side, and shows all stars similar in magnitude to those of Argelander's Durchmusterung. The lens employed is a "rapid rectilinear lens," composed of two combinations, having an aperture of 6 inches and a focal length of about 52 inches. The exposure of each plate is one hour, and the plates are the most sensitive "Paget dry plates," specially made for that purpose. Mr. Finlay, of the Cape Observatory, stated at a meeting of the Liverpool Astronomical Society, on October 13, 1885, that a 9-inch lens had been ordered and would soon be ready. It is proposed to divide the whole southern hemisphere into sixty squares, each one overlapping another adjoining it. Two plates are taken of each picture, so as to avoid any mistake. The work will take from three to four years, and will comprise 1,000 pictures. Mr. C. Ray Woods has been put in charge of this work, and he intends to continue at the Cape the work of photographing the corona, which he lately undertook, under Dr. Huggins' direction, in Switzerland.

COMETS.

Theory of comets' tails: Les syndynames et les synchrones dans les comètes, 25 pp., 1 plate, 4to. *Les syndynames et les synchrones de la comète Pons-Brooks.* 24 pp., 1 plate, 4to.—"M. Bredichin, while sharing some of Bessel's ideas concerning the existence of a repulsive force, has succeeded in developing a complete theory concerning the tails of comets; a theory which accounts very satisfactorily for most of the observed phenomena. M. Bredichin applies the name *syndyname* to the parabolic curve in which the particles of the tail that have successively left the nucleus under the influence of a given repulsive force μ, are disposed at the moment of observation. The *synchrone* is the curve in which occur the particles that have left the nucleus at the same time under the influence of several forces μ, μ', ...

"The synchronic lines are limited and intersected by the syndynames of the edges of the tail. In the case of the Donati comet, Norton found these lines to be nearly straight, passing near the nucleus. According to Bredichin, the synchrones are rather circles of great radius, the radius for each comet increasing and diminishing with the radius vector. When the emission of matter is intermittent, the synchronic circles signalize the maxima by clear bands converging toward the nucleus. The clear bands are really hollow conoids, more or less flattened in the direction of the plane of the orbit.

"In the two memoirs before us, which are taken from the Annals of the Moscow Observatory, M. Bredichin successfully applies his theory to different comets, of which we possess sufficiently accurate drawings, and especially to the comet of 1744 and to the Pons-Brooks comet (1884). They also contain a reproduction of the refutation of the criticisms of M. Marcuse." (Radau, *Bull. Astron.*, September, 1885.)

Computation of comet orbits.—In the twentieth volume of the *Vierteljahrsschrift der Astronomischen Gesellschaft* (pp. 287–312) will be found in full Professor Weiss's exceedingly interesting report on the present state of the computations of the orbits of comets, presented at the meeting of the Gesellschaft on the 19th of August, 1885. *Nature* contains the following report of this communication:

"Of the twelve periodical comets returned at different times to their perihelion, eight had again been regularly determined by the same calculators. Of the remaining four, three were removed from our present care: Biela's, which, as was known, had been lost to observation, and the comets of Halley and Pons-Brooks, whose next perihelion lay too remote in the future. There was consequently but one periodical comet (Brorsen's) to be taken account of. As to the remaining non-returning comets, of the 168 which had appeared in this century, forty-one were to be regarded as settled; twenty-three had their orbits pretty well determined. In the case of fifty-eight comets a new calculation of the orbit was desirable for various reasons, and in all forty-six had yet to be calculated definitely. There was, therefore, a wide field of labor open. Professor Weiss accordingly sought to commend to the society the establishment of a common calculation bureau on the settlement of the questions at issue, while the exact detailed treatment of a particular comet should in future, as hitherto, be left to the initiative of a single calculator. In the discussion following this address, Staatsrath Struve argued against the founding of such a bureau on the ground that the comets were of too peculiar a nature to accommodate themselves to the methodic treatment of a calculation bureau."

Holetschek: Uber die Bahneines Kometen, der - - - nicht aus den Sonnenstrahlen heraustreten kann Wiener Sitzungsberichte, December, 1883. (88: 1099–1162.)—It will be remembered that at the time of the total eclipse of May 17, 1882, the French, English, and Italian astronomers who met at Sohag, Egypt, observed the presence of a comet near the sun;

it was photographed by Tacchini and Schuster, and a drawing made of its tail by Trépied; but the comet was not seen again. It was this incident that induced Herr Holetschek to determine the conditions that must be fulfilled by the orbit of a comet that remains concealed by the sun's rays during the time that its absolute brightness (determined simply by the formula $J=\frac{1}{r^2\rho^2}$) is sufficient to admit of its discovery.

Herr Holetschek judges from the examples furnished by the comets of the last ten years that the magnitude of a comet remaining invisible at its perihelion cannot be greater than from 0·06 to 0·12 for an elongation approaching 15°, certainly not for one of 22·5° (the calculation was made for these two elongations). In order that it may remain visible in the two branches of its orbit, its orbit must offer a certain symmetry in reference to the earth's radius vector; the heliocentric latitude of the perihelion must then be sufficiently small, and the comet must be in conjunction with the sun at the time of its passing its perihelion.

These results, which are not at all rigorous, suffice to show that the unobserved perihelion transits of comets may not be as infrequent as would have been supposed. We know of periodic comets whose returns sometimes elude observation. But there are others which would have always remained unknown if their transit had occurred at any other time of the year; such, for example, is the comet of 1821 ($q=0.09$, $i=106°$). The Sohag comet belongs very probably in the same category as this last; its perihelion distance must have been very small. (Radau, *Bull. Astron.*, July, 1885.)

Galle's supplementary list of recent comets.—Dr. J. G. Galle, the eminent director of the Breslau Observatory, has communicated to the *Nachrichten** (Nos. 2665 and 2666)† a most valuable summary of the orbit elements of comets from 1860 to 1864, with a similar list of newly computed orbits of comets earlier than 1860. Brief notes generally relating to the discovery and period of visibility of the comet, and to the elements given, accompany each orbit.

Dr. Galle's paper has been reprinted in *Sirius*, vol. 18, and a translation of the portion relating to comets since 1860 has appeared in the *Sidereal Messenger* (vols. 4 and 5). The present list is supplementary to the catalogue given in the third edition of "Olbers' Methode zur Berechnung der Cometenbahnen," so that taken in connection with the latter it forms the most complete catalogue of comets that is now available. At the end of the year 1884 the number of different comets of which orbits have been computed was 302. The number of apparitions of comets, including the present recorded returns of periodic comets, is considerably greater:

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* Ueberischt über die Bahn-Elemente der seit dem Jahre 1860 exschienenen Cometen, sowie über neu berechnete oder verbesserte Bahnen von Cometen der früheren Zeit.

† See also *Astron. Nachr.*, 2692.

D'Arrest's comet has been observed 4 times.
Biela's comet has been observed 6 times.
Brorsen's comet has been observed 5 times.
Encke's comet has been observed 23 times.
Faye's comet has been observed 6 times.
Halley's comet has been observed 7 times.
Pons's comet has been observed 2 times.
Tempel's (1) comet has been observed 3 times.
Tempel's (2) comet has been observed 2 times.
Tempel's (3) comet has been observed 2 times.
Tuttle's comet has been observed 3 times.
Winnecke's comet has been observed 4 times.

Accordingly, 67—12=55 repeated apparitions are to be added, bringing up to 357 the total of the observed appearances of comets. In this summary, of course, no allowance is made for the great uncertainty of many of the older orbits, or for the fact that in some cases it is doubtful whether the *same* periodic comet has been seen.

The comets are arranged strictly in the order of their perihelion passage. This is a long-established system and one possessing numerous advantages; furthermore, it has lately been made the rule of the *Astronomische Gesellschaft.* The uncertainty sometimes existing in the designation of particular comets during the year of discovery can always be easily removed, for the time being, by the addition of the name of the discoverer. Moreover, a strict adherence to this system of numbering comets in each year has become necessary of late, partly on account of the great number of comets discovered, and partly on account of the considerable increase of the known periodic comets during the last forty years. The actually observed returns of these comets must of course be arranged with the other comets. Since in many cases the periodicity has first been established at the second apparition, and in a few cases at the third, the exclusion of periodic comets from the list of apparitions of each year would frequently cause annoying changes in the designations of earlier years. In the publications of the past ten years the periodic comets, particularly, have led to a great many differences in the designation of comets, an evil which is not merely of a theoretical nature, but, for those who often have occasion to refer to the literature of comets, is one which carries with it very real and practical inconveniences, frequently necessitating much troublesome comparison of observations, or of ephemerides, to decide what comet is really referred to. Especially in years in which a great many comets are seen, if the names of the discoverers are not given, not only is there great loss of time, but besides this mistakes easily occur.

Comets of 1883.*—The great comet of 1882 (1882 II), which excited so much interest in the latter part of the year 1882, was visible to the naked eye till February, 1883, and with the telescope was followed, in the southern hemisphere, to the middle of the year, the last accurate observation being on May 26, at Cordoba. The comet was seen again on June 1 at the same place, but was too faint to admit of a satisfactory determination of its position. It was then at a distance of 5·1 from the sun and 4·4 from the earth. In addition to this comet, two others were visible during the year, 1883 I and 1884 I; and a comet discovered on January 7, 1884, was found to have passed perihelion on December 25, 1883, and is accordingly catalogued with the comets of the latter year. A comet was also reported as Comet *c*, 1883, on September 11, but it proved to be a nebula; and a second comet, with a tail 2° or 3° long, was reported as seen before sunrise at Tasmania on the mornings of December 25 and 27, 1883. Nothing more is known of it. Two other comets have passed perihelion during the year, but, owing to unfavorable circumstances, have not been seen—D'Arrest's comet on January 13, 1883, and Tempel's comet of 1873, on November 20.

Comet 1883 I:
=Comet *a* 1883.
=Swift-Brooks Comet.

Discovered February 23, by W. R. Brooks of Phelps, N. Y., and on the same day, a few hours later, by Swift, at Rochester. The comet had already passed perihelion (on February 18). Its orbit does not resemble any previously computed, nor does it show any signs of eccentricity. The spectrum was of the ordinary three-band type.

Comet 1883 II:
=Comet *a* 1884.
=Ross's Comet.

This comet was discovered by Ross, an amateur observer, at Elsternwick, near Melbourne, Australia, on January 7, 1884. The spectrum showed faintly the three hydro-carbon lines. A careful discussion of the orbit has lately been made by Mr. Bryant. The observations are few and not very satisfactory, and Mr. Bryant finally based his results on Tebbutt's observations alone. Two sets of elements were derived; one gave a period of eighty-seven years, and the other ninety-four years, but both orbits satisfy the observations.

Comets of 1884.—Of the five comets visible during the year, four were periodic—two of these of short period, and observed apparently for the first time at this return. The first comet discovered during the year has just been described as Comet 1883 II. The second discovery was by Barnard on July 16, and the third by Wolf, on September 17. To these we add Encke's Comet, 1885 I, detected by Tempel, at Arcetri, on December 13, and the Pons-Brooks Comet, which passed perihelion on January 25. To complete the list we should mention a suspected comet to which some interest is attached: A faint nebulous object was found by Spitaler with the 27-inch refractor of the Vienna Observatory, while searching for Comet 1858 III, on the morning of May 26, 1884. A period of almost unexampled bad weather followed, and on June 17 and 18 the of nebula was missing. Schulhof seems to think it improbable that this was the comet. Brorsen's Comet, which has a period of about five and one-half years, was due at perihelion in September, 1884, but owing to its unfavorable situation it seems to have escaped observation.

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*This section is purposely made to include the comets of 1883, 1884, and 1885, in order to complete former records.

Comet 1884 I:
= Comet *b* 1883.
= Pons-Brooks Comet.
= Pons Comet 1812.

A faint telescopic comet was discovered by Brooks on September 1, 1883, and it soon proved to be a comet which had been discovered originally by Pons, at Marseilles, on July 20, 1812—one of a group, of which Halley's Comet is another member, having a period of about seventy-five years and an aphelion a little beyond the orbit of Neptune. Schulhof and Bossert's careful rediscussion of the observations of 1812 had placed the return to perihelion on September 3, 1884, whereas perihelion passage was actually found to take place on January 25. A closer agreement (the error was only $\frac{1}{122}$ of the whole amount) could hardly have been expected, considering that the older observations extended over barely two months. The corrected elements make the period 71·56 Julian years. As the second member of this group to return to perihelion, this comet had been looked for with considerable interest, and that interest was subsequently increased, when observation showed the rapid changes suffered by the head in approaching the sun, and the curious fluctuations in the brightness of the nucleus. On the evening of September 22 the comet was described as a faint, round nebula, with a nucleus of the 12th magnitude. On September 23 the nucleus had become as bright as the 8th magnitude. This central mass, according to Schiaparelli, was not a point of light, but had an appreciable diameter, and an irregular outline. It now diminished quite rapidly in brightness, and was noted as the 9th magnitude on September 29. Another outburst occurred on January 1, 1884, and a careful series of photometric observations was obtained by Dr. Mueller, of Potsdam. The nucleus became as bright as a star of the 7th magnitude, the change in brightness amounting to more than a magnitude in about an hour and a half. The comet was visible to the naked eye from November 20 to March 3, and at its brightest, with a tail 6° long, it was a fairly conspicuous object in our southwestern sky. The spectrum on the 24th and 27th of September showed nothing unusual. On January 1 Vogel found a continuous spectrum of considerable intensity, in which two bright lines were suspected in the yellow. The bands were fainter in the nucleus than in the parts immediately surrounding it. Vogel concludes from his observations that in consequence of the rapid condensation of the cometary matter into a bright nucleus of several seconds in diameter, a considerable increase in temperature must have taken place, by which the most refrangible band in the comet's spectrum increased so in intensity that it almost equaled the brightness of the middle band, in the green, and decidedly surpassed the band in the yellow.

Comet 1884 II:
= Comet *b* 1884.
= Barnard's Comet.

A comet first seen by Barnard, at Nashville, Tenn., on the night of July 16. During the whole period of its visibility (to about November 20) it remained an inconspicuous object. The changes in brightness, as in other comets recently observed, was neither uniform nor consistent with the law of reflected light. The comet was found to move in an elliptic orbit with a period of about 5·4 years, the elements bearing a very close resemblance to those of De Vico's lost comet (1844 I), though the two do not appear to be identical. The spectrum showed two of the cometary bands, the middle one and that in the red; the third was only suspected. This comet perhaps belongs to the fainter class of those revolving in a short period, and this year was probably observed under somewhat favorable circumstances. Perihelion was passed on August 16.

Comet 1884 III:
= Comet *c* 1884.
= Wolf's Comet.

Discovered by Max Wolf, at Heidelberg, on September 17, and independently, with the spectroscope, by Copeland, at Dun Echt, on September 22. The last observation appears to have been by Young, at Princeton, on April 6, 1885. This comet, like the preceding, was moving in an ellipse of short period (6¾ years), and one of the most interesting facts in connection with it was the near approach (about 8,000,000 miles) that it must have made to Jupiter in May, 1875. It seems not at all improbable that from the perturbations experienced at that time, it was brought into its present orbit. Krueger has pointed out that at the returns (consistent with a period of 6¾ years) in 1871 and 1878 the comet was unfavorably situated for observation. In 1864 and again in 1891 the situation is favorable, if we can suppose that it follows the same path as now. During the whole period of its visibility the comet was an insignificant object physically. The spectrum as observed at Nice was continuous, with the three cometary bands. Perihelion was passed on November 17.

Comets of 1885.—During the year 1885 seven comets have been under observation; two were discovered by Barnard, two by Brooks, and one by Fabry, a student at the Paris Observatory. Two of the known periodic comets, Encke's and Tuttle's, were expected to return this year and both were found. Two other periodic comets, Tempel's 1867 II, and Tempel-Swift 1869 III, were also expected, and were carefully looked for; but they were unfavorably situated, and seem to have passed unobserved. A suspicious object, thought to have been Tempel's comet 1867 II, was observed at Geneva in March, but its identity was not fully established.

Comet 1885 I:
=Comet *d* 1884.
=Encke's Comet.

Encke's comet, at this its twenty-third return, was found by Tempel, at Arcetri, on December 13, 1884, close to the place given by Backlund's ephemeris—a faint nebulous mass without any defined nucleus. By the 1st of February a condensation, situated a little eccentrically, as in 1881, was seen, and by the middle of February the faint trace of a tail was visible. Perihelion occurred on March 7. The comet showed quite a bright banded spectrum, while the continuous spectrum of the nucleus was made out only with considerable difficulty.

Comet 1885 II:
=Comet *a* 1885.
=Barnard's Comet.

A telegram was received on July 9, at Harvard College observatory, from Prof. L. Swift, of Rochester, announcing the discovery of a comet by Prof. E. E. Barnard on the evening of July 7, at Vanderbilt University, Nashville, Tenn. The position given was identical with a nebula, No. 4301, of *Herschel's General Catalogue*, and the announcement dispatches were delayed until the fact of the non-identity was established. The comet was seen at Cambridge on the night of July 9. On the 11th of July, as observed by Charlois, at Nice, it consisted of a nucleus of the 105 magnitude, surrounded by a faint, irregular nebulosity about 1′·5 in diameter. Professor Young, observing with the 23-inch refractor at Princeton, describes the comet during July as about three quarters of a minute of arc in diameter, somewhat elongated, and much condensed in the center, though without any true stellar nucleus; no structure of jets or envelopes could be made out. There was, however, a faint, slightly fan-shaped tail from 2′·5 to 4′ long, directed at a position angle of about 35°. Professor Young found the spectrum almost continuous, the usual cometary bands being visible only as three slight intensifications of brightness upon the uniform background. A similar spectrum was observed at Nice. The comet appears to have been seen as late as September 2. Several sets of elements have been computed; the peculiarity of the orbit, its great perihelion distance, being brought out by all. The perihelion distance, (2·5) is greater than in the case of any other comet hitherto computed, excepting the extraordinary one of 1729, which did not approach the sun within four times the earth's mean distance. A conjecture having been expressed by Faye and Krueger that the orbit might be elliptic, Dr. Lamp computed elliptic element, and found a period of eighty-seven hundred years, He remarks, however, that owing to the uncertainty in the single observations employed, his results can hardly be considered as decisive, and the orbit may yet turn out parabolic. The comet passed perihelion in the early part of August, the several orbits thus far computed ranging in this element from August 1 to 9.

Comet 1885 III:
=Comet *c* 1885.
=Brooks's Comet.

Discovered by W. R. Brooks, of Phelps, N. Y., on August 31, 1885, and also, independently, by A. A. Common, at Ealing, on September 4. Professor Pickering, who obtained the first accurate position, September 2, describes the comet as of about the 9th magnitude, with circular nebulosity 2′ in diameter, some central condensation, and no tail. It changed very little from this during the few weeks it was visible. According to Dr. H. Oppenheim's orbit, perihelion was passed on August 10, and the comet steadily decreased in brightness from the time of discovery. The nearest approach to the earth seems to have been about September 25.

Comet 1885 IV:
=Comet *b* 1885.
=Tuttle's Comet.
=Comet 1790 II.
=Comet 1858 I.
=Comet 1871 III.

This comet, originally discovered by Méchain in 1790, and rediscovered by Tuttle in 1858, was found at this return by Perrotin and Charlois at the Nice Observatory on August 8, and was observed on each of the following days to August 13, by Charlois. Owing to the faintness of the comet and its slight elevation above the eastern horizon at sunrise, observation was possible for only ten or fifteen minutes. M. Charlois describes the comet as a white spot, about 2′ in diameter, without any central condensation. On August 10, with exceptionally good atmospheric conditions, he thought the nebulosity was elongated in the direction of the meridian.

Herr Rahts, of Koenigsberg, has taken up the work of Tischler, and has deduced an orbit from the observations of 1853 and 1871–'72, with perturbations by Mercury, Venus, the Earth, Mars, Jupiter, Saturn, and Uranus, to July 11, 1885. He obtains a period of revolution of 13·76 years, with perihelion passage on September 11, 1885.

Comet 1885 V:
=Comet *f* 1885.
=Brooks's Comet.

Discovered by Brooks on December 26, 1885, or more than three weeks after the two following comets. It was also, independently, discovered by Barnard on the evening of December 27, making the third comet found by Barnard in 1885, and the second by Brooks. It is described as circular, about 3′ in diameter, equivalent to a star of the 9th magnitude, and with a strong, eccentrically placed condensation. The provisional elements computed by Chandler and Wendell show that the comet is growing fainter, having passed perihelion on November 29.

Comet 1886. .. (Fabry):
=Comet *d* 1885.
=Fabry's Comet.

Discovered on December 1, 1885, by M. Fabry, a student at the Paris Observatory, where he had been engaged for about three months in a search for new comets, with the equatorial coudé. At the time of discovery the comet presented the appearance of a faint round nebulosity (12th magnitude) about 1′ in diameter, with a small, central, stellar nucleus. On December 9 it was observed to be elongated in the position angle of 87°. According to a calculation of its orbit made by M. Lebeuf, perihelion passage occurs on April 5, 1886. The distance from the Earth decreases till the end of April, when the theoretical brightness will be nearly 500 times as great as on the date of discovery.

Comet 1886... (**Barnard**):
= Comet *e* 1885.
= Banard's Comet.

This comet, the second discovered by Barnard during the year, was foundin the constellation Taurus on December 3, 1885. It is described by Tempel, on December 10, as somewhat brighter than Fabry's comet, small, about equal to a nebula of class II, with a star-like center. Elements and ephemeris thus far published show that the comet is increasing in brightness, and that it does not reach perihelion till May, 1886. Dr. Oppenheim's ephemeris places the maximum brilliancy about May 25, nearly 400 times as bright as at discovery; but its proximity to the sun at this time will detract considerably from its splendor.

Periodic comets due in 1886.—Of the now somewhat numerous list of comets of short period, two will be due at perihelion in the ensuing year: (1) The comet Tempel-Swift, or 1869 III, and 1880 IV, which is likely to return under circumstances that will render observations impracticable, so far at least as a judgment can be formed without actual calculation of the perturbations; (2) Winnecke's comet, last observed in 1875, its track in the heavens near the perihelion passage in December, 1880, not allowing of the comet being seen at that return; the perturbations may be very sensible during the present revolution; neglecting their effect, the mean motion determined by Professor Oppolzer for 1880 would bring the comet to perihelion again about August 24·5 . . . The actual orbit of Winnecke's comet approaches very near to that of the planet Jupiter in heliocentric longitude 110°, at which point the comet arrives seven hundred and twenty days, or 1·97 years, before perihelion passage; the distance between the two orbits is then less than 0·06 of the earth's mean distance from the sun.

It is very possible, however, that the comet which may most interest astronomers in 1886 will be that observed in 1815, and known as Olbers' comet, which, according to the elaborate calculations of Dr. Ginzel, will again arrive at perihelion in December, 1886. The most probable date that can be inferred from the observations of 1815, and the computation of planetary perturbations in the interval, is December 16, but unfortunately the observations did not suffice to determine the mean motion in 1815 with precision, and consequently Ginzel found for the limits of the period of revolution 72·33 and 75·68 years; hence the comet may reach its perihelion many months earlier or later than the date given by calculation.

Extensive sweeping ephemerides have been published, and it may not be too soon to direct attention to a search for the comet at the beginning of the next year, or as soon as the region in which its orbit is projected at the time can be advantageously examined. (*Nature*, October 29, 1885.)

METEORS, AND THE ZODIACAL LIGHT.

Meteor shower of November 27, 1885.—On the evening of November 27 there was a remarkable shower of meteors radiating from Andromeda, and presumably connected with Biela's comet, very nearly two revolutions of which had elapsed since the previous great appearance of these bodies in 1872.

In Europe and Asia the star shower was very remarkable wherever the clouds did not prevent its being seen; in this country it was nearly over before sunset, yet in the early evening the meteors were numerous enough to attract very general attention. It would also appear that showers of meteors were observed from this stream not only on the night of November 27, but also at some places on nights preceding and following.

An adequate discussion of the observations can only be made after all the reports are in. Tolerably complete summaries of the accounts thus far published may be found in *Ciel et Terre*, vol. 6, pp. 451, 491, and *Sirius*, vol. 19, p. 33.

"It will be very interesting to notice in 1898 how far the brilliancy of the display to which we may then look forward will be affected by the comparatively slightly altered position in its orbit of the principal aggregation of meteors, which would seem to be a little behind what would have been the place of the comet."

The zodiacal light.—In October, 1883, Prof. Arthur Searle presented to the American Academy of Arts and Sciences a very valuable paper on the zodiacal light, in which he had collected and reduced on a uniform system the evening observations of all the principal observers. The principal points then brought out were that in all probability the apparent changes in the latitude of the zodiacal light were due mainly, if not entirely, to the effect of atmospheric absorption, and that the method of observation by drawing outlines must be replaced by careful photometric observations if definite knowledge was to be substituted for the vague information we now possess as to the "Gegenschein," the "zodiacal bands," &c.; and Professor Searle concluded with the suggestion that the ordinary meteoric theory would gain greatly in simplicity by the substitution of meteoric dust scattered generally throughout the solar system for the meteoric rings that have been usually imagined. Professor Searle has continued his investigations in a recent memoir, in which he corrects, for the effect of atmospheric absorption, Jones's observations of what the latter called the "stronger light," at the elongation 60°, whether made in the morning or evening. The result of the inquiry is to confirm the view arrived at previously, that atmospheric absorption largely affects the apparent position of the zodiacal light, and Professor Searle again lays stress on the need for photometric observations. Professor Searle concludes that, after correcting for atmospheric absorption, there seems reason to think that the zodiacal light has had, during the present half-century, a more northern latitude near the longitude 180° than near the longitude 0°. He also shows, from a careful study of the distribution of the stars in the Durchmusterung, that upon the meteoric theory of the zodiacal light it is to be expected that a continuous zodiacal band should be present; but the question of its actual visibility is complicated by the slight maxima of stellar density which are situated along those parts of the ecliptic most readily accessible to observation from stations in the northern hemisphere. An interesting result is obtained from an examination of the elements of the 237 asteroids first discovered, from which it would seem that the belt of sky occupied by the projections of the orbits of these asteroids "presents certain peculiarities which correspond to those of the zodiacal light, and suggest the hypothesis that the light may be partly due to minute objects circulating in orbits like those of the smaller planets." (*Nature.*)

THE SUN.

Langley's researches on solar heat.—"The results of the work upon which Professor Langley has been engaged for the last several years have recently been published in a complete form as Volume XV of the Professional Papers of the United States Signal Service. No work more thoroughly aggressive, more calculated to further the progress of science and to render it secure, has been undertaken during late years than that which Professor Langley has carried out, chiefly by means of his ingenious and useful instrument, the bolometer. - - - The first chapter contains the preliminary observations made at Allegheny, from which Professor Langley deduced the value of the solar constant as 2·84 calories, a much larger quantity than that generally accepted hitherto. The observations also showed him that, contrary to the generally received opinion, absorption occurred in the visible portion of the spectrum, particularly in the green and blue, and that it diminished as the extreme infra-red was approached, and convinced him that the labor and expense involved in repeating the observations at the base and at the summit of a lofty mountain would be well repaid by the gain in our knowledge.

"In July, 1881, therefore, Professor Langley started for Mount Whitney, a lofty eminence in the Sierra Nevada of Southern California, over 14,000 feet in height, which seemed to combine all the needed requirements. The second chapter gives an interesting account of the journey to Mount Whitney. Then follow several chapters of results of observations and descriptions of the instruments used. Amongst these were a water pyrheliometer after Pouillet's model, a mercury pyrheliometer, two globe actinometers, a 'solar comparator,' and the spectrobolometer. In Chapter xiv the amount of the atmospheric absorption is shown to be about 40 per cent., or double that usually supposed. Then follow chapters on 'Sky Radiation,' 'Nocturnal Radiation,' &c. Chapter xxi gives a general summary of the results; and the most probable value of the 'solar constant' is given as 3 calories. Three appendices follow, on the reduction of psychrometer observations, the determination of wave-lengths in the invisible prismatic spectrum, and also of the influence of convection currents on thermometer bulbs. The work is illustrated by twenty-one plates, mostly the observation curves of the different instruments, besides a map of the district of Mount Whitney, showing the proposed reservation and a view of the mountain camp.

"The principal results of Professor Langley's work may perhaps be briefly summarized as follows: He has shown that the invisible spectrum beyond the red extends much further than was imagined or believed possible; he has detected cold spaces in this spectrum analogous to the dark absorption bands and lines of the visible spectrum, and has determined their wave-lengths. He has shown that all the old formula for the determination of wave-lengths in the prismatic spectrum failed utterly when carried into the infra-red region. The amount of absorption exercised by the atmosphere has been proved to have been greatly under-estimated; it is at least double what has been usually supposed, and the value of the 'solar constant' has been increased in consequence. Contrary to the theory hitherto universally held, Professor Langley has shown that the infra-red rays do not suffer the most absorption, but the visible rays, and especially those in the green and blue, the transmissibility steadily increasing towards the extreme infra-red. From this it follows that what we call white light is not 'the sum of all radiations,' but that remainder of rays which has been filtered down to us, and the sun, could we see it as it is, would appear of a decided bluish tint. Professor Langley's observations seem also to indicate that at a certain point far in the infra-red, transmissibility through the atmosphere suddenly ceases, and it would seem to follow that the earth heat which fails to be radiated away through the atmosphere must be lower than we have yet examined in any spectrum. The old idea of a 'temperature of space' is rejected, and reasons are given for concluding that the heat we receive from celestial bodies, other than the sun, is practically *nil*. Finally, Professor Langley concludes that the temperature of the earth under direct sunshine, even though our atmosphere were present as now, would probably fall to 200° C. if that atmosphere did not possess the quality of selective absorption. To this catalogue of results may be added that the volume before us gives abundant evidence of the attention and care which Professor Langley has given to free his work from every source of error." (*Observatory*, September, 1885, p. 309.)

We can only refer by title here to a lecture on "Sunlight and the earth's atmosphere," delivered by Professor Langley at the Royal Institute, April 17, 1885, a full report of which has appeared in *Nature* (vol. 32, p. 17, 40), and to his interesting and admirably illustrated astronomical articles on "The New Astronomy," in the *Century* for September, October, and December, 1884, and March, 1885.

Diameters of the sun and moon as observed with the Greenwich transit circle (W. G. Thackery).—The author considers the values of the diameters of the sun and moon furnished each year by the result of all the observations, and also the values resulting each year from the work of the individual observers. The following results were found for the sun, with which are given the results obtained by Sir G. B. Airy, in a paper entitled "On the Circularity of the Sun" (*Monthly Notices*, vol. XXII):

Period.	No. of obsns.	Hor. Diam.	No. of obsns.	Vert. Diam.	Authority.
		′ ″		′ ″	
1853 to 1860	795	32 2·65	851	32 2·61	Airy.
1861 to 1883	2,185	32 2·28	2,317	32 2·62	Thackeray.

The difference in the values of the horizontal diameter is rather surprising when compared to the identity of the values of the vertical diameter; but the personal equation must be taken into account in considering the observations, the following table showing its importance:

Tabular errors of the sun's vertical diameter, according to different observers.

Observer.	Tabular error.	No. of obsns.
	″	
Dunkin	+2·28	138
Ellis	—0·19	269
J. Carpenter	+3·13	191
Criswick	+1·65	347
Lynn	—1·59	149
Downing	+1·70	203
Thackeray	+1·01	141
Lewis	+0·48	72
Hollis	+0·15	44

The observations extend from 1861 to 1883. The error as found by one observer often varies with the time. As to the horizontal diameter found by the transits of the two limbs, the following results have been given by Mr. Dunkin in Vol. XXXV of the *Monthly Notices*, p. 91, for the period 1864 to 1873:

Tabular errors of the horizontal diameter.

Observer.	Tabular error.
	″
Dunkin	+0.87
Ellis	+1.48
Criswick	+0.31
Lynn	+1.05
J. Carpenter	+2.45

Mr. Thackeray has also considered the observations of the moon's diameter. In this case the personal equation is almost insensible, and the correction to the *Nautical Almanac* is unimportant.

One result of the preceding discussion is to show that it would be proper in reducing incomplete observations of the sun (observations of one limb only) not to adopt a uniform value for the diameter, but to employ the observer's own value. (*Bull. Astron.*, August, 1885.)

List of eclipses.—Dr. Theodore von Oppolzer, of Vienna, announces the early publication of a very extended list of the dates of solar and lunar eclipses which has been prepared under his direction. There will be eight thousand of the former and more than five thousand of the latter class of phenomena, and all included between the years 1207 B. C. and 2161 A. D. In publishing the hours of the day at which the eclipses will occur, Dr. Oppolzer will adopt the new reckoning of astronomical time recommended by the International Prime Meridian Conference at Washington in 1884, thus making this publication the first astronomical work of importance in which this method of counting the hours of the day is adopted.

Eclipse of the sun, 1869, *August* 7.—The report of observations of the total eclipse of the sun of August 7, 1869, made by parties under the direction of Prof. J. H. C. Coffin, superintendent of the American Ephemeris and Nautical Almanac, has been published during the year, the delay in the appearance of the volume being due to the illness of Professor Coffin. The results of the work of Professors Young, Gould, Pickering, Morton, and others have already been known through other channels, but many valuable details are now given for the first time. Ten plates accompany the work, among them some excellent engravings from the photographs at totality.

Eclipse of the sun, 1885, *March* 16.—This was visible as a partial eclipse throughout the United States, and as an "annular" eclipse in the northwestern part; the annulus describing a path about 75 miles wide, across Montana, Idaho, and the northwestern part of California.

A circular was sent out by the Superintendent of the Naval Observatory stating that time signals would be sent to observers along this line, and requesting that observations of the beginning and ending of the eclipse and of the annular phase should be transmitted to the observatory. Reports were received from sixteen observers, and many of these reports, together with an account of observations made at the Naval Observatory, embracing observations of contact, observations made with the transit instrument and transit circle, and results from photographs made with the transit of Venus photo-heliograph, are published as Appendix II to the Washington observations for 1882.

Observations of contact were made by Professor Peters at Clinton, and photographs were taken at the Chicago and Lick Observatories. Mr. Charles H. Rockwell observed the annular phase from Delta, Cal.

Eclipse of the sun, 1885, *September* 9.—The track of the line of total eclipse lay almost wholly in the South Pacific Ocean, the only land on which the total phase was observable being the shores of Cook's Straits, New Zealand. The duration of totality was about two minutes at the point most favorably located. "It would appear that no central eclipse has traversed these islands during the present century; an examination of the various ephemerides points to the annular eclipse of December 29, 1796, as the last which was there central. An annular, though nearly total, eclipse will take place near the north extremity of the North Island on January 3, 1927, while on May 30, 1965, when the sun is barely risen to an altitude of 5°, he will be totally eclipsed on the east coast of the North Island, near its north extremity, for about $2^m\ 20^s$."

From the reports we have seen it would appear that many of the parties which were organized for the purpose of observing the expected phenomena were seriously interfered with by bad weather. At Tahoraite, a point well within the belt of totality but some 40 miles north of the central line, Mr. Graydon succeeded in obtaining five sketches during totality; these sketches show five or six long rays (besides a large number of shorter ones) projecting from the sun's limb, the longest ray being some two or three diameters of that body in length. A dark rift was observed in the corona, and near this rift a red flame was noticed by some of the bystanders to shoot out just before the end of totality. Photographs were obtained at Blenheim, at Masterton and at Nelson; and other observations were made at Wellington, Dryertown, and Palmerston.

Eclipse of the sun, 1886, *August* 28–29[*].—The eclipse of August 28–29, 1886, will be total only in the torrid zone, and the path of the total phase will fall mainly in the open Atlantic Ocean, but at Benguela, on the western coast of South Africa, it will be observable at about 3 o'clock of local time in the afternoon. It will be remembered that this eclipse is of rather more than ordinary interest on account of the long duration of totality, $4^m\ 41^s$, near Benguela. Another interesting circumstance has been noticed by Dr. Herz, of Vienna, in the fact that at totality two stars, 47 ρ Leonis and 49 Leonis, are close to the sun, the latter within the corona. It is suggested that by means of measurements upon these two stars, something may be learned in regard to the refracting power of this peculiar atmosphere of the sun. A bill is now pending before Congress, appropriating $10,000 to enable the Secretary of the Navy to fit out an expedition to observe this eclipse.

Transit of Venus.—From Professor Harkness's[†] report to the president of the American Transit of Venus Commission, we make the following extract:

"At the date of my last annual report experiments were in progress to determine whether or not the heliostat mirrors undergo any change of curvature when exposed to the sun's rays. As that question is of vital importance in the theory of the horizontal photo-heliograph, it was thought desirable to make the experiments both in the heat of summer and in the cold of winter. The work was completed on February 23, 1885.

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[*] See, also, Account of Progress of Astronomy, 1883, Smithsonian report, p. 391.

[†] See Report of Superintendent U. S. Naval Observatory, 1885, p. 12.

"Mr. Rogers is now engaged in writing an account both of the processes employed in preparing and developing the dry collodion emulsion plates used with the photo-heliographs in observing the transit of Venus in December, 1882, and of the experiments which were executed to determine the best method of making pyroxyline for that purpose. Whenever photographs are required which must sustain the test of accurate measurement, the collodion emulsion process offers advantages so great that every effort should be put forth to increase its general availability. Some of our recent experiments incidentally tend in that direction, and although primarily made to clear up obscure points relating to the transit of Venus work, it is hoped they will facilitate the application of collodion emulsion in future operations requiring the use of photo-heliographs. In these experiments pyroxyline has been made from flax, jute, etc., as well as from cotton, which is the form of cellulose commonly preferred.

"It will be remembered that wet bromo-iodide plates, made by the bath process, were used with the photo-heliographs in observing the transit of Venus in December, 1874, and the question naturally arises whether or not the negatives then obtained are strictly comparable with those made upon dry collodion emulsion during the transit of December, 1882. For the definite settlement of that point recourse was had to photographs of the solar spectrum. In June, 1881, a set of such photographs was made upon wet bromo-iodide bath plates of the kind used in December, 1874, and similar sets are now being made with emulsions as nearly as possible in the same condition with respect to age, etc., as those actually employed in observing the transit of December, 1882. In order to show clearly the progressive action of the solar rays upon the silver salts, each set begins with the shortest exposure capable of producing an easily legible impression, and extends to exposures two or three hundred times as great. The negatives have not yet been subjected to critical examination, but the general result seems to be that, while marked differences exist in the action of the spectrum upon the two classes of plates with the exposures given in the photo-heliographs, the effective rays are of substantially the same wave-length in both. The transit plates of 1874 and 1882 are therefore quite comparable in this respect, and there is no reason to apprehend systematic differences between them depending upon atmospheric dispersion. The spectrum photographs have also established the fact that the emulsion plates have a degree of sensitiveness not very different from that of bath wet plates."

The reduction of observations for time and latitude made at the various United States stations in December, 1882, are now nearly completed and to a considerable extent prepared for printing. It is expected that they will form Part III of the Transit of Venus Reports. No progress has been made in the reduction of the photographs during the current year, and it is not proposed to take them up again until after all the manuscript relating to time, latitude, and longitude has been prepared for the printer.

The work of printing Part II of the Transit of Venus Reports has recently been resumed, and will probably be completed at an early date. This part will form a volume of about five hundred quarto pages, and will contain the records of all observations made at the United States stations for observing the transit of 1874, together with the corresponding reductions and discussions, excepting only those relating to the photographs.

The French photographs of the transit of Venus.—The measurement of the seven hundred photographs obtained at the various French stations during the transit of Venus, 1882, is about to be commenced. An office has been organized for the purpose, the necessary credit has been granted, and a measuring instrument belonging to the Meudon Observatory and lent by M. Janssen, has been supplied. This will be replaced in January, 1886, by a smaller one by the same makers, MM. Brunner Frères. The measurements, it is expected, will be completed in fifteen months.

Photographic evidence as to the constitution of sun spots.—"M. Janssen, remarking on some exquisite photographs of sun spots which he has obtained during the past year, calls attention to the evidence they supply as to the continuation of the granulation of the general solar surface, into the spots. A photograph of the great spot of 1885, June 22, for example, to which he particularly alludes, shows that the bright region which surrounds the penumbræ of large spots has not a different constitution from that of the photosphere in general, since it is made up in like manner of granular elements, usually of a spherical form. The marked increase in brightness of such regions the photographs show to be due to the granulations being more thickly clustered, brighter in themselves, and arranged on a brighter background. In the penumbra the granulations are still distinguishable, but they are less luminous and more scattered, leaving dark gaps between the rows of grains, the familiar striated appearance of the penumbra being due to the arrangement of the granulations in ranks and lines, like beads on a thread. The grains become in general smaller and duller near the nucleus, where they seem to dissolve. The same spot presented two very remarkable bridges, and a very bright isolated mass of luminous matter which united them. This luminous matter and the bridges were also formed of granular elements resembling the others. Many other photographs have revealed a similar structure in penumbræ and their surroundings, so that it is highly probable that 'the luminous matter which forms the solar surface has everywhere the same constitution.'" (*Nature*, February 4, 1886.)

Sun-spot maximum.—The exact epoch of the last sun-spot maximum, which for some time remained in uncertainty, has been placed by Wolf at 1883·9, and his result has been confirmed* by the observations of the past year. The previous maximum was well marked at 1870·6 and with the 11-year period (more exactly 11·1 years) the next was expected at 1881·7 or the beginning of 1882; and in fact in April, 1882, a "false" maximum did occur, but with the finally established maximum at 1883·9 we have a retardation of about two years. The interval from the preceding maximum is therefore 13.3 years, and from the preceding minimum of 1879·0, 4·9 years. It is quite remarkable also that the variations of the magnetic needle have shown a similar anomalous fluctuation.

The Solar Corona† (*a lecture delivered at the Royal Institution, by* Dr. Huggins, *February* 20, 1884).—"After mentioning the various hypotheses concerning the nature of the corona (a gaseous atmosphere, fine particles ejected by the sun and in motion around the sun caused by several forces, one of them being perhaps the repulsive force observed in the case of comets, a center of meteoric streams, etc.), Dr. Huggins speaks of Dr. Hastings's new theory, according to which the corona is not a reality but simply a phenomenon caused by diffraction. Without dwelling upon the proof of its reality furnished by photographs made when there was no eclipse, and consequently no intervention of the moon, Mr. Huggins finds that the analysis of the spectra of different parts of the corona and the peculiar structure seen in the photographs taken during eclipses contradict Dr. Hastings's theory. If Dr. Hastings's theory were correct the corona would of necessity change during the course of the eclipse and the photographs reveal no change. M. Janssen says: 'Les formes de la couronne ont été absolument fixes pendant toute la durée de la totalité.'

"The sun is doubtless surrounded by a gaseous atmosphere of a certain extent, but there are a number of reasons why the corona should not be regarded as a prolongation of this atmosphere. A gas even a hundred or a thousand times lighter than hydrogen at the height of the corona would, at the sun's surface, be heavier than metals,—a state of things which spectroscopic and other observations show cannot be the true one. The corona does not show either that rapid condensation towards the sun which an atmosphere would show, especially if we take into account the effect of perspective in increasing the brightness of the lower parts of the corona. Moreover, comets have been known to pass through the upper part of the corona without losing either matter or velocity.

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* Sur le statistique solaire de l'année 1885. *Compt. Rend.* 102: 161.

† See The Observatory, vol. 8, p. 153.

"There can be no doubt that the corona shows us matter existing about the sun in the form of a fog, of which we may form some idea by imagining the air we breathe very much rarefied but still full of particles rendered visible by a sun's ray. The matter of the corona sends us three kinds of light: Solar light dispersed by particles of matter, either solid or liquid; light giving a continuous spectrum, showing that the solid or liquid particles are incandescent, and light giving spectra of brilliant lines, fainter and varying greatly at different parts of the corona and at different eclipses, which must be due to the presence of a luminous gas. This gas existing between the particles does not form a solar atmosphere in the true sense of the word (such an atmosphere has already been shown to be impossible), but this gas may be regarded as carried along by the particles; it is due perhaps to the heat of the sun.

"Comets show characteristics which are not without analogy to those of the corona; in the case of comets we see reproduced on a small scale the luminous streams, the rifts and curved rays.* We do not know the conditions under which these cometary appearances occur, but the generally accepted hypothesis attributes them to electrical action, and especially to a repulsive force acting from the sun, and doubtless an electrical force, which varies with the surface, and not, like gravity, with the mass.* A force of this nature could easily overcome the force of gravity, and, as we see in the tails of comets, drive very much rarefied matter to immense distances. Such a repulsive force, if electrical in its origin, must act between bodies charged with the same kind of electricity, and according to this theory the material of which the corona is composed and the surface of the sun must be in the same electrical state; a certain permanence of the same electrical state would seem to be required by the phenomena of the tails of comets; but we are quite in ignorance on this subject.

"However this may be, it is quite in conformity with the ideas expressed above, that the positions of greatest coronal extension should usually correspond with the spot zones where the solar activity is greatest. A careful investigation of the structure of the corona leads us to think also that the forces to which this complicated and variable structure is due have their seat in the sun. Matter repelled by the sun would participate in the rotary velocity of the photosphere, and lagging behind give rise to curved forms. Moreover, the force of the projection and the subsequent electrical repulsion might very well vary in direction and not be always strictly radial, and this would help to explain the character of the corona. The relative permanency of some of the coronal forms during several weeks does not imply that the matter is immovable; flames over the mouths of volcanoes often offer a similar appearance. If the forces to which the corona is due reside in the sun, the corona ought, of course, to revolve with it; but if the corona is produced by causes extraneous to the sun, it may be otherwise.

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* See "Comets," *Royal Institution Proceedings*, Vol. x, p. 1.

"We have seen that the corona probably consists of an incandescent fog, which, at the same time, sends us by reflection the light of the photosphere. Now we must remember that there is a great difference in the behavior of a gas and of liquid and solid particles in the immediate vicinity of the sun. A gas need not be greatly heated even when near the sun by the radiated energy; when once heated it would rapidly lose its heat when above the photosphere; but solid and liquid particles, whether carried up as such or having become such by condensation, would absorb the sun's heat and at the distance of the corona would reach a temperature but little inferior to that of the photosphere. The gas shown by the spectroscope to exist among the incandescent matter of the corona may therefore have been carried there as gas or may have been in part distilled from the coronal particles under the influence of the enormous solar radiations. There would be no discordance between this theory and the fact of the very different heights at which the brilliant lines in the corona have been observed. Gases of unequal densities, unequally repelled by a repulsive force varying as the surface, would be to a certain degree separated, the highest gas being most influenced by the repulsive force, the heaviest being most influenced by gravity. The relative proportions at different heights of the corona of the gases, whose presence is shown by the spectroscope, vary from time to time and depend in part upon the state of activity of the photosphere in such a way as to establish a probable connection with the spectrum of the protuberances. (Captain Abney and Professor Schuster have recently shown that beside the bright lines already known, the spectrum of the corona of 1882 gave the group of the ultraviolet lines of hydrogen, which are characteristic of the photographic spectra of white stars, and other lines also.) In this view of the corona, therefore, we find a new example of such relations as those existing between the phenomena of sun spots and magnetic perturbations or auroræ.

"Many questions are left unconsidered, this among others, whether the light emitted by the gaseous part of the corona is due directly to the sun's heat or to electrical discharges of the nature of the aurora. Further, what becomes of the coronal matter on the theory which has been suggested? Is it permanently carried away from the sun as the matter of the tails of comets is lost to them? Electric repulsion can continue only so long as the repelled particles remain in the same electrical state. If the electrical state changes, the repulsion must cease, and, gravity no longer counteracted, the particle must fall back to the sun. In Mr. Wesley's drawings of the corona, especially in those of the eclipse of 1871, the longer rays or streamers seem not to end but to be lost in the fainter parts of the drawing; but some of the shorter ones seem to turn and descend to the sun.*

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* Concerning the nature of the corona consult the papers of Norton, Young, and Langley in the *American Journal of Science*, *The Sun*, by Professor Young, and various essays by Mr. R. A. Proctor.

"It is difficult for us living in dense air to conceive of the state of attenuation probably present in the outer parts of the corona. Mr. Crookes has shown by experiment that matter reduced to one-millionth part of the density of ordinary air is still possessed of a sufficient number of molecules to display a perfect corona when under the influence of an electric current. In any case we may hope that our present knowledge on the subject will be much increased by the daily photographs of the corona, which are about to be commenced at the Cape by Mr. Ray Woods under the direction of Dr. Gill." (*Bull. Astron.*, June, 1885.)

Professor Young on the solar corona.—In an article on "Theories regarding the sun's corona," in the *North American Review*, Professor Young expresses "his complete conviction that the corona is mainly solar." He points out that the corona sends us three kinds of light, the spectroscopic evidence showing that reflected or diffused sunlight is present, though not the main constituent of the coronal luminosity, the continuous spectrum indicating the presence of incandescent particles, solid or liquid, whilst the bright lines show the presence of luminous gases. These mingled gases form what has been called the "coronal atmosphere," but in it "there are filaments and streamers and other forms that are probably not gaseous, but composed of mist and dust; some of them may be of meteoric origin, and some composed of matter ejected from the sun, while others perhaps are due to condensation of vapors." The analogy of the channels in the tails of comets to the coronal rifts, and the evidence comets afford to a repulsive force exercised by the sun, strike Professor Young as they do Dr. Huggins: "All the luminous phenomena of the corona could be accounted for by an atmosphere of a density millions of times below that in any vacuum-tube ever constructed."

Photographing the corona in full sunshine.—Mr. W. H. Pickering, of the Institute of Technology, Boston, made a series of attempts during the partial eclipse of March 16, 1885, to obtain a photograph of the corona. In this he was quite unsuccessful, for though his plates showed several corona-like markings, they were clearly not due to the true corona, as they were found in front of the moon as well as on the sun's limb. From this Mr. Pickering was evidently led to conclude that the results which Dr. Huggins had obtained were probably of a similar character, and he expressed as much in a letter to *Science.* Dr. Huggins in reply pointed out that Mr. Pickering's method was faulty and was calculated to produce such false images. The latter, therefore, somewhat modified his apparatus without, however, altering the two points which Dr. Huggins considered most erroneous, viz, the use of an object-glass instead of a reflector, and the placing his drop-slit close in front of the object-glass instead of in its primary focus. The result has been that he has obtained photographs free from false coronæ, but showing no real ones. At the same time he has made experiments which convince him that to produce a perceptible image of a coronal rift it is necessary to be able to discriminate between degrees of illumination which do not differ from each other by more than one-tenth the intrinsic brilliancy of the full moon. He considers that the eye is more able to detect small differences of light than a photograph is, and states that the moon cannot be photographed in full daylight, even though it may be easily seen. His investigations also lead him to think that even in the clearest weather the atmospheric illumination is three hundred times as bright as it should be for it to be possible to obtain any image of the corona. To these points Dr. Huggins has replied in the *Observatory* for November. Dr. Huggins states that he has had no difficulty at all in photographing the moon in full sunshine, and that the observations of Professor Langley and others, of Mercury and Venus, which have been seen as black disks before they reach the sun, proves that the corona must have a sensible brightness as compared with the atmospheric illumination.

He also points out that Mr. Pickering fails to obtain any trace on his photographs even of the detects of his own instrument. Dr. Huggins declines further discussion, preferring to wait the result of the work now being carried on by Mr. Ray Woods at the Cape Observatory. Mr. Pickering replies in *Science* for October 23, admitting the possibility of photographing the moon in full sunshine, but contending that these very photographs of the moon supply an additional proof of his opinion that the light of the atmosphere near the sun is more than three hundred times too intense for it to be possible to obtain a photograph of the corona, since the skylight near the sun was fifty times as bright as that near the moon, and coronal photographs to be of any use should be able to record differences of illumination of only one-tenth the brightness of the full moon.

He explains the visibility of Venus and Mercury as being caused by the refraction of the sun's light through their atmospheres, the black disk being thus surrounded by a narrow luminous ring. (*Nature.*)

*Remarkable solar prominences.**—On the 26th of June, 1885, a remarkable prominence was noticed upon the eastern limb of the sun by M. Trouvelot, of the Meudon Observatory. Its measured height was about 10′·5, or about a third of the sun's diameter, but it probably extended somewhat further. At a point on the sun's limb diametrically opposite, another immense prominence was seen nearly equal in height to the first. A somewhat similar phenomenon—two opposite prominences—had been observed on November 22, 1884.

On August 16, 1885, at $9^h\ 25^m$, M. Trouvelot observed a brilliant prominence 4′ in height, which by $11^h\ 20^m$ had increased to 9′ 27″. With the increase in height, it diminished rapidly in brightness, and at $11^h\ 22^m$ had completely disappeared.

Peculiar prominences were also remarked by M. Ricco, of the Palermo Observatory, September 16–19, and by M. Trouvelot on September 27.

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* *L'Astronomie*, 4 : 441–7.

Rowland's photograph of the normal solar spectrum.—This map has been made by Professor Rowland of the Johns Hopkins University, with one of his concave gratings of 21½ feet radius of curvature and 6 inches diameter, and is now complete from wave-length 3680 to 5790; the portion above 3680 to the extremity of the ultra-violet, wave-length about 3100, is nearly ready. Negatives have also been prepared down to and includign *B*, and it is possible they may be prepared for publication; a scale of wave-lengths has been added. "The error in the wave-length at no part exceeds $\frac{1}{50000}$ of the whole, and is generally caused by a slight displacement of the scale, which is easily corrected. The wave-lengths of more than 200 lines in the spectrum have been accurately determined to about $\frac{1}{500000}$ part, and these can serve as standards to correct any small error of the scale. - - - The 1474 line is widely double, as also b_3 and b_4, while *E* is given so nearly double as to be recognized as such by all persons familiar with spectrum observation. Above the green the superiority increases very quickly, so that at *H* we have 120 lines between *H* and *K*, while the original negatives show 150 lines. The photographs show more at this point than the excellent map of Lockyer of this region."

THE PLANETS.

INTRA-MERCURIAL PLANET.—The report[*] of a committee of the National Academy of Sciences, to which was referred the question of the expediency of fitting out an expedition to the west coast of Africa for the purpose of observing the total eclipse of the sun on August 28–29, 1886, contains the following remarks in regard to the hypothetical planet revolving within the orbit of Mercury: "In addition to the observation of the sun itself, and the luminous phenomena attending it, it is desirable to obtain photographic maps of all the surrounding region to the distance of at least ten or fifteen degrees from the sun, for the purpose of finally setting at rest the still mooted question of an intra-mercurial planet. It is true that the astronomical world is at present disposed generally to discredit the existence of such a body, yet the evidence on the subject up to this time is mainly negative, as it must always continue to be so long as it depends upon direct vision. In a photographic map, taken during total eclipse of the sun, of the whole region within which such a planet must necessarily be confined, the object, if present, must present itself, and could not fail to be recognized. But for photographic operations of this class, lenses of wide angle must be specially prepared, differing essentially in character from those which are employed to take impressions of the eclipse."

A search for the "supposititious Vulcan" was again made by Mr. T. W. Backhouse, of Sunderland, England, in March and April, 1885—the period during which a transit is possible, according to Leverrier—but with no positive result. Mr. Backhouse says: "I consider the question of the existence of Vulcan can only be settled by continued and *systematic* watching for its appearance in transit, as at the time of an eclipse of the sun it may be too near that luminary to be visible."

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[*] Senate Ex. Doc. No. 67, Forty-ninth Congress, first session.

The EARTH: *Variability of terrestrial latitudes.*—The question of the variability of terrestrial latitudes was brought anew to the attention of astronomers by the International Geodetic Conference at Rome in October, 1883. A plan for settling the question by observation was proposed by M. Fergola, an Italian astronomer, which was, essentially, that a careful series of observations should be made with prime vertical instrument, by two co-operating observatories differing but little in latitude though, perhaps, considerably in longitude. The same list of stars was to be used at each pair of such stations. By repeating these observations after an interval of fifty years or more, the question of the variability of latitudes would be subjected to a severe test. Theoretically, periodical changes of latitude may occur, and an examination of observations made at a number of Northern observatories during the past seventy-five years—Königsberg, Milan, Naples, Paris, Pulkowa, and Washington—appears to confirm the existence of such changes. At Pulkowa, which furnishes the most careful series of observations, a diminution of the latitude of 0″·23, equivalent to about 23 feet, is indicated between the years 1843 and 1872; but in all these cases the variations are small, and we must be extremely cautious in ascribing them to actual changes of latitude. A recent and very complete discussion of the latitude of the Greenwich Observatory by Mr. Christie gives no evidence of a secular change of latitude, and a later determination of the latitude of the Washington Observatory (in 1883) also furnishes no proof of a change.

Prof. Asaph Hall, in a paper* read before the Philosophical Society of Washington, February 28, 1884, has given a discussion of the observations tabulated by M. Fergola. His conclusion is that "observations do not prove that latitudes are variable, and the evidence points rather to other sources of small changes that may depend on the seasons. Perhaps some of these may arise from the tables of refraction which are in common use, and which are assumed to fit the whole earth."

Some preliminary steps have been taken towards putting Fergola's plan in operation at the observatories of Lisbon and Washington (the difference of latitude being 11′ 7″), but we believe no observations have actually been made yet.

Effect on the earth's motion produced by small bodies passing near it.—Professor Newton points out† that the space through which the earth travels is traversed also by small bodies, or meteoroids. The impact of these bodies upon the earth, and the consequent increase of the earth's mass, have their effect upon the earth's motions, both of rotation and

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***Amer. J. Sci.*, 3 s. vol. 29, p. 223–27; also *Observatory* 8, p. 113–17.

†*Amer. J. Sci.*, December, 1885, 3 s., vol. 30, p. 410–17.

revolution, and hence upon the lengths of the day and year. Professor Oppolzer (*Astron., Nachr.*, 2573) has discussed the amount of these actions, and has computed the density which the meteoroid matter must have in order to produce the observed and unexplained acceleration of the moon's mean motion. But a body that passes near to the earth has also an action of like charactér due to the attraction of gravitation alone, and Professor Newton proceeds to calculate its amount. The conclusion at which he arrives is that the effect upon the earth's motion of the meteors that come into the earth's atmosphere exceeds at least one hundred fold that of the meteors that pass by without impact. (*Observatory.*)

Determination of longitudes in South America.—According to *Science* (vol. v, p. 151), Commander Davis has just completed his important telegraphic determinations of longitude on the western coast of South America. The great chain connecting Washington with different points in South America, and then extending through Saint Vincent, Madeira, Lisbon and Greenwich, is now closed with but an insignificant discrepancy.

The proposed change in the beginning of the astronomical day.—No general agreement has been reached by astronomers upon the sixth resolution of the Washington Meridian Conference, which recommends that the astronomical and nautical days be arranged everywhere to begin at mean midnight. The matter was brought up at the Geneva meeting of the *Astronomische Gesellschaft* in 1885. (See *Vrtljhrschr.*, 20, p. 227–31.) Struve, Folie, and Pechüle seemed to be the only members present in favor of the change, while Newcomb, Weiss, Krueger, Dunér, Auwers, Tietjen, and Safarik spoke in opposition to it. Mr. Downing, of the Greenwich Observatory, says (*Nature*, 32 : 353), " - - - and judging from the individual expressions of opinion that have been published, I should imagine that here, as at Geneva, the majority of real workers in our science (with the probable exception of those engaged in solar work) would be opposed to the proposed change."

In the United States, official action has been taken by the Secretary of the Navy, referring the question to the National Academy. The report (Senate Ex. Doc. No. 67, Forty-ninth Congress, first session) of a committee of that body consisting of Pres. F. A. P. Barnard, Profs. A. Graham Bell, J. D. Dana, S. P. Langley, Col. Theodore Lyman, Profs. E. C. Pickering, and C. A. Young says: "The committee regard favorably the proposition of the meridian conference on this subject, and recommend that the change should be made as soon as sufficient concert of action can be secured among the leading astronomers and astronomical establishments of the civilized world—in 1890, if practicable; if not, in 1900."

It would seem to be incumbent on those astronomers who have expressed themselves in favor of the proposed change, and of the consequent interruption of astronomical chronology, to justify strongly their position. It is not quite clear that this has been done, for while many reasons are given *against* the change, almost the only argument in its favor (besides that of convenience in solar work) is, that there will be established a certain uniformity of time-reckoning between astronomers and the world at large.

In addition to the references given above, we should call attention to the following papers upon this important question:

BALL (R. S.). Proposed change in the astronomical day. *Observatory*, 9 : 100.

FLEMING (S.). Universal or cosmic time. Toronto [1885].

FOERSTER (W.). Ueber die von der conferenz zu Washington proponirte Veränderung des astronomischen Tagesanfanges. *Astron. Nachr.* 111 : 33–8.

LETTER from the Secretary of the Navy transmitting communications concerning the proposed change in the time for beginning the astronomical day [from the superintendent of the Naval Observatory, the superintendent of the Nautical Almanac, and various American astronomers]. Senate Ex. Doc. No. 78, Forty-eighth Congress, second session.

NEWCOMB (S.). On the proposed change of the astronomical day. *Month. Not. Roy. Astron. Soc.*, 45 : 122.

VON OPPOLZER (Th.) On the proposed change of the astronomical day. *Month. Not. Roy. Astron. Soc.*, 45 : 295–8.

STRUVE (O.). Die Beschlüsse der Washingtoner Meridianconferenz. St. Petersburg, 1885. 27 p. 8vo.

"*Sky-glows: Certain phenomena in meteorological optics that have occurred since the close of the year* 1883. *Hypothesis concerning the cause and origin of these phenomena.*—The immediate cause of the "red sunsets" seems to be the existence at a very great height in the atmosphere of a cloud, or rather a light mist, composed of very fine particles. This hypothesis would explain the twilight phenomena when the sun was 18° or 20° below the horizon. We need not suppose these particles to have had a greater altitude than 60 or 70 kilometers during the first of these apparitions.

"The red color of these lights corresponds very well with the absorptive power of the atmosphere which physicists observe in the sun's radiations at different altitudes and astronomers in the ruddy tint presented by the moon's disk in total eclipses;* the distance traversed through the atmosphere by the sun's rays before reaching this cloud explains sufficiently the intensity of the coloring.

"The solar corona and the anti-solar aureole could be easily explained with this hypothesis if the particles held in suspension in the atmosphere are supposed to offer a sensibly constant mean diameter, as the theoretical conditions for diffraction coronas would then be present.

"The next question is, What is the origin of these particles suspended in the atmosphere? The reply to this question is quite independent of the explanation of the phenomena of meteorological optics presented above. There have been a number of hypotheses on this subject. The first, seeking an explanation in the ordinary domain of meteorological influences, gives as the origin of these particles the formation of very minute ice crystals like those which appear to constitute the cirrus clouds. The trouble with this very simple hypotheses is that so many additional hypotheses are required to sustain it. For some hypothesis must be made as to the cause of the production of frozen clouds at an unusual altitude. Some reason must be assigned for their permanence during months and even years. And the question why optical phenomena, halos, mock suns, &c., which accompany the ordinary existence of ice crystals in the atmosphere do not appear permanently must be answered.

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* The total eclipse of the moon October 4, 1884, did not show this red color in the usual degree. This is regarded by some as a proof of the existence of these clouds of particles, the higher regions of the atmosphere being rendered less transparent by their presence.

"Although it might be possible to find explanations for all these points of difficulty, it is evident that the proposed hypothesis is simple in appearance only, and that it meets with difficulties rather than with confirmations in the observed facts.

"The second hypothesis attributes to these particles a cosmic origin, that is to say, the same origin as is assigned to meteors; the earth is supposed to have passed in its orbital motion through a cloud of small particles, revolving, like herself, about the sun, and to have drawn after her all the particles within her sphere of attraction. This hypothesis seems at first thought a very satisfactory one; the twilight lights, at first so brilliant, have been growing fainter. This accords with the idea that the particles have come from some external source, and have by degrees fallen, in the order of their size, to the earth's surface. The explanation appears all the more plausible since true rains of dust have been observed in different countries. Nordenskjöld made a chemical examination of a sample of this dust, collected in Sweden, and found it to contain iron and nickel, elements that are present in meteorites. Still, this argument is not decisive, for rains of dust, whose origin is certainly terrestrial, have often been observed; as, for example, the dry fogs, well known in southern Europe, composed of mineral dust brought by the wind across the Mediterranean from the desert of Sahara. This dust has been collected at sea by sailors, and also on the coasts, and has been found to contain silica, feldspar, and mica, elements of the sands of the African desert.

"Volcanic ashes have been sometimes found in Norway, coming from the eruptions of Iceland volcanoes; the microscope shows these to contain fragments of pumice and even crystals of pyroxene. The cosmic origin of these particles must therefore be sustained by more direct proofs, if it is to be accepted.

"The third hypothesis connects the diffusion of these clouds of particles with the frightful cataclysm at Java, when 50,000 persons lost their lives through the explosion of Krakatoa. Nearly all the arguments employed by the partisans of the cosmic origin apply with equal force to this volcanic origin. It explains why the first twilight manifestations appeared directly after the eruption at Java, nothing of the kind having been observed before; it explains, moreover, the progressive march of the apparition of these lights about the center of explosion. This progressive march renders the cosmic origin of these particles quite improbable, for in case of a cosmic origin there seems to be no reason why the phenomenon should not appear nearly simultaneously at all points on the earth's surface. Those regions on the Indian Ocean forming the trajectory of a cyclone show in a convincing manner that the ashes of the Java volcano, caught up by the ordinary winds of that quarter, are the cause of the extraordinary sunsets in question.

“The objection may be raised that the height of these particles is very great in comparison to the height to which the smoke of our European volcanoes rises; but, after reading M. Verbeck's report, these objections disappear before the greatness of this volcanic convulsion. A quantity of matter, whose volume was estimated at 150 cubic kilometers, was seen projected 18 or 20 kilometers above the crater. When we think that the gaseous matter that escaped at the same time must represent a volume some hundreds of times as great, we cease to be astonished at the thought of the diffuse dust reaching an altitude of 70 or 80 kilometers. As to the suspension of these particles in the air, it at least does not contradict what we know of the laws of the air's viscosity, nor of the action of winds, heat, and atmospheric electricity.

“A more detailed discussion of the documents published on the subject of this frightful explosion would carry us beyond the scope of this simple article; enough has been said to show that these optical phenomena, of which our atmosphere has been for some eighteen months and is still the scene, may be referred with great probability if not certainty to a volcanic origin.” (Cornu, in *Bull. Astron.*, April, 1885.)

THE MOON: *Lunar heat.*—At the Albany meeting of the National Academy of Sciences in October, 1885, Professor Langley read a paper “On the temperature of the surface of the moon.”

Attempts were made in the last century by several physicists to obtain indications of heat from the moon, but without success. Professor Forbes, in 1885, employed a lens by which the lunar heat was concentrated about 6,000 times, but obtained no certain evidence of heat, being led only to the negative conclusion, that the warming effect of the full moon on the surface of the earth would, at any rate, not exceed $\frac{1}{300000}$ of a degree, Centigrade. The first satisfactory evidence of actual heat was obtained by Melloni in 1846, who, with a polyzonal burning lens, one meter in aperture, and by the aid of the newly invented thermopyle, in the clear air of Vesuvius, after due precaution against instrumental error, succeeded in obtaining decisive indications of heat, although the amount was all but immeasurably small. Later observers were also able to do little more than detect evidence of the existence of lunar heat, and the first attainments of anything like quantitative measurement thereof, was reserved for Lord Rosse, whose experiments are recorded in the proceedings of the Royal Society, commencing in 1869. The paper now before us details the experiments by Professor Langley, at the Allegheny Observatory, with the instrument invented about five years ago, and denominated the bolometer. The first of these were made on the evening of November 12, 1880, chiefly with the view of testing its sensitiveness, concentrating the lunar rays upon its face by means of the 13-inch equatorial of the observatory, and a smaller convex lens near its focus, when an average deflection of forty-two divisions of the galvanometer scale was obtained. In June, 1883, the bolometer and its adjuncts, having been much improved in the interval, measurements of the lunar heat were resumed with apparatus better adapted to the purpose. The heat radiated from the lunar surface may consist of three kinds in different proportions: (1) Heat coming from the interior of the moon, which will not vary with the phase; (2) heat which falls from the sun on the moon's surface, and is at once reflected regularly and irregularly; (3) heat which, falling from the sun on the moon's surface, is absorbed, raises the temperature of the surface, and is afterwards radiated as heat of low refrangibility. The general conclusion of Professor Langley's observations is thus expressed by himself. "While we have found abundant evidence of heat from the moon, every method we have tried, or that has been tried by others, for determining the character of this heat appears to us inconclusive; and without questioning that the moon radiates heat earthward from its soil, we have not yet found any experimental means of discriminating with such certainty between this and reflected heat that it is not open to misinterpretation. Whether we do so or not in the future will probably depend on our ability to measure by some process which will inform us directly of the wave-lengths of the heat observed." Combined with his experiments on solar radiation, Professor Langley's investigations seem to point to the probability of a gaseous envelope to the moon, too small to make its presence known in ordinary astronomical observations; and it is well known that Mr. Neison has advocated this view from other considerations in his great work on the moon. (*Athenæum.*)

Eclipse of the moon, 1884, *October* 4.—In spite of the very unfavorable atmospheric conditions in Central Europe, nearly forty observatories participated in the observation of this eclipse and were able to furnish valuable material, which will be made the subject of a special publication when the positions of all the occulted stars shall have been determined with the necessary precision. While awaiting the termination of this great piece of work, Professor Struve gives a succinct résumé of the results due to the co-operation of so many workers in the *Astronomische Nachrichten*, Nos. 2640–46.

MARS: *The rotation period of Mars.*—The seventh volume of the *Annals* of the Leyden Observatory contains a very thorough and painstaking investigation by Professor Bakhuyzen of the rotation period of the planet Mars. In previous determinations one of two courses has usually been adopted, either to compare drawings of Huygens or Hooke with the most recent observations attainable, or to discuss some modern series which seemed to promise to compensate for its restricted range by its greater accuracy. Professor Bakhuyzen has, however, endeavored to utilize the entire mass of observations at his disposal, so as to avoid the sources of error to which the other methods are liable, and he possesses a great advantage over earlier investigators, in having access, not only to the numerous observations made in 1877 and 1879, but also to the great series of more than 200 drawings which Schroeter had prepared for his projected "Areographischen Beiträge," and which becoming the property of the University of Leyden in 1876, was edited and published by Professor Bakhuyzen in 1881. Professor Bakhuyzen, in the reduction of these drawings, has adopted provisionally Schiaparelli's position for the pole of Mars—R. A. 317° 46′·0, Decl. 53° 25′·4, mean equinox of 1833·0—and Proctor's rotation period—$24^{h}\ 37^{m}\ 22^{s}{\cdot}74$—and deduces corrections to these elements from a comparison of the results obtained by reducing the various observations at his command with them. His first step is, from a discussion of the drawings of Kaiser, Lockyer, Lord Rosse, and Dawes, made during the oppositions of of 1862 and 1864, to obtain the time of transit on January 1, 1863, of his adopted prime meridian over the Martial meridian, which passes through the earth's north pole, choosing as his prime meridian the one which lies 2° to the east of the center of Mädler's point *a*, corresponding almost exactly to Schiaparelli's *Fastigium Aryn*, or to Proctor's *Dawes Forked Bay*, he finds the time of transit over the meridian passing through the north pole of the earth on January 1, 1863, to be $20^{h}\ 27^{m} \pm 4{\cdot}0^{m}$, Berlin M. T. The areographic longitude of the center of the *Oculus*, the conspicuous circular spot, called by Green the *Terby Sea*, and by Schiaparelli *Lacus Solis*, will be, with this prime meridian, 90°·87. The second section contains the determination of areographic longitudes of ten of the most conspicuous and easily identified markings on the surface of Mars as inferred by means of the above elements from the drawings of various observers from the time of Hooke and Huygens up to 1879. For the last-named year only Schiaparelli's observations are used, but for 1877 there is an abundant supply, there being available, besides the observations of Schiaparelli, the drawings of Lohse, Green, Dreyer, and Niesten. Beer and Mädler's drawings afford material for 1830, Herschel and Schroeter give a very full series from 1777 to 1803, and Huygens and Hooke supply a few drawings from 1659 to 1683, from which the longitude of Mädler's *f*, the *Kaiser* or *Hourglass Sea*, Schiaparelli's *Syrtis Major*, can be inferred. These logitudes are discussed in the third section, and a corrected rotation period is obtained of $24^{h}\ 37^{m}\ 22^{s}{\cdot}66 \pm 0^{s}{\cdot}0132$, a value exceedingly close to the mean of the best previous determinations, which are as follows:

	h.	m.	s.
Kaiser, 1864	24	37	22·62
Kaiser, 1873			·591
Schmidt, 1873			·57
Proctor, 1868			·735

"Proctor's value is clearly too large, a comparison of the mean longitudes obtained for the *Kaiser Sea* with his period showing a steady decrease for successive oppositions; the only observations which stand conspicuously out from the rest being those of Hooke, upon which he had based his determination. There can be no doubt that Professor Bakhuyzen's value is a distinct improvement upon the earlier ones, and that its uncertainty lies only in the second place of the decimals. A table for computing the time of transit of the prime meridian over that meridian of Mars which passes through the earth's north pole, completes the memoir.

Professor Bakhuyzen supplies also a short note as to changes on the surface of Mars. The most conspicuous of all the markings on the planet's surface has always been the *Kaiser Sea;* but the drawings of Schroeter and Herschel, as Dr. Terby has already pointed out, exhibit a second marking near it, nearly as conspicuous, and very similar in shape and size. There can be no doubt that the only modern representative of this spot is *Huggins Inlet*, Schiaparelli's *Cyclopum*, a narrow streak, by no means easily observed, and now entirely unlike the *Kaiser Sea* in shape. Professor Bakhuyzen also considers that there is sufficient evidence for thinking that Schroeter on several occasions observed Schiaparelli's *Læstrygonum*—one of the most difficult objects on the planet—which could scarcely have been the case had it not been much more conspicuous than it has been of late years. These changes, Professor Bakhuyzen thinks, lend a high degree of probability to the theory that certain districts of Mars are covered by liquid." (*Nature*, November 12, 1885.)

JUPITER: Mr. W. F. Denning has given in *Nature* (32: 31–34, May 14, 1885) a summary of recent observations of the markings on Jupiter, with resulting rotation periods, &c. The great red spot has surprised us by its extended duration. As early as 1882 it lost such a considerable depth of tone that obliteration seemed imminent, but it has lingered on, until now its existence appears likely to be indefinitely prolonged, though under visible conditions far less imposing than at an earlier stage. All that at present remains of this remarkable formation is a dusky elliptic ring, darkest at the following end, and only well seen under good definition. Whether this ellipse is identical with similar appearances delineated by Dawes in 1857, Huggins in 1858, and Gledhill in 1869, 1870, and 1871, is involved in doubt, because of the lack of intermediate observations. We have no definite information as to what became of the various objects alluded to. It is very possible that they severally represent an object of considerable permanency. The changes such as observed may have been induced by atmospheric interference. There is every indication that the dense vaporous envelopes of this planet are rapidly variable, especially in the zone included by the two equatorial belts, and that the chief features undergo singular fluctuations, some of which may possibly be of periodical character. The red spot has now been followed since 1878. During the last three years it has given a rotation period of $9^{h}\,55^{m}\,39^{s}{\cdot}1$, which has been steadily maintained throughout each opposition, subject to some minor disturbances partly due to errors of observation. The first few years of its existence it showed an increasing retardation of motion, which lengthened the period from $9^{h}\,55^{m}\,34^{s}$ to that already quoted, but, contemporarily with the decay of the spot in 1882, the velocity ceased to slacken, and the results accumulated during the past few oppositions, prove it to have been equable in a marked degree.

With reference to the equatorial white spot some striking phenomena have been presented during the past winter. Between October 4, 1884, and January 13, 1885, its motion appears to have increased in an alarming ratio. The spot continued to rush on far in advance of its computed places, and all the while exhibited a more brilliant appearance than at any preceding epoch since the autumn of 1880, when it first came under systematic observation. The form and appearance of the spot have been so special as to prevent any confusion in mistaking it for other white spots in nearly the same latitude. Between October 4 and January 13, 1885, the rotation period was $9^{h}\,49^{m}\,51^{s}{\cdot}95$, but the great increase in velocity evidently occurred towards the end of November. Between November 21, 1884, and January 13, 1885, the period was only $9^{h}\,49^{m}\,38^{s}{\cdot}45$, or 34 seconds less than the mean period of $9^{h}\,50^{m}\,12^{s}{\cdot}25$ shown by the same spot during the two preceding years.

"Of the new features presented during the last few months the most striking are:" (1) The appearance of large, bright spots indenting the north edge of the great northern equatorial belt. (2) The outbreak of dark, reddish spots, elongated in longitude, upon the narrow belt which became visible in 1882, immediately outlying the great belt. One of the most conspicuous of these new spots is about 10,000 miles long. (3) The fading away of the west shoulder of the depression north of the red spot.

Professor Young remarked[*] a peculiar white cloud of oval form partially covering the "red spot," in March, 1885. This veil was almost concentric with the spot, leaving visible only a narrow ring of the red substance not more than 1½″ to 2″ in width. The outline of the cloud was for the most part sensibly smooth and regular, but at the preceding end there was a little projection nearly cutting across the red ring. The white cloud was not brilliant, but was very nearly of the same tint as the white belt on which the red spot lies.

At the Dearborn Observatory, Chicago, the systematic observation of the markings on Jupiter has been continued by Professor Hough: his results are given in full in his annual report for 1885, which contains sketches of the planet on November 7, 1884, and February 27, April 26, and May 15, 1885.

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[*] *Observatory,* VIII: 172.

SATURN: *The density of Saturn's ring.*—" M. Poincaré supplies a short note on the stability of Saturn's ring in the November number of the *Bulletin Astronomique.* Laplace had shown that the ring could only be stable if it were divided into several concentric rings revolving at different speeds. M. Tisserand had confirmed this result, and had recognized that a single ring must, in order to exist, possess a much higher density than the planet, and had calculated the maximum breadth of each elementary ring in terms of its density and mean radius. M. Poincaré has carried this investigation a step further, and shown that if the density of a ring be less than a certain amount, it will, under the influence of the slightest perturbation, no longer break up into a number of narrower rings, but into a great number of satellites, and that if the rings be fluid and turn each as a single piece, the density of the inner ring must be at least $\frac{1}{5}$, and of the outer ring $\frac{1}{16}$ that of the planet. For a ring of very small satellites (not for a fluid ring, as M. Poincaré erroneously states), Maxwell has shown the condition to be that the density should not *exceed* $\frac{1}{300}$ part of that of Saturn.

" We do not at present know the actual density of the ring from observation sufficiently accurately to make therefrom any certain inference as to its physical condition. Bessel's determination from the movement of the peri-saturnium of the orbit of Titan gave the reciprocal of the mass of the ring as compared with that of Saturn as 118, which since the volume of the ring—adopting Bond's value of 40 miles for its thickness—is about $\frac{1}{400}$ that of the planet, would make its density about 3·4 times greater than the planet's. Bessel's value is, however, clearly too great, as he neglected the influence of the equatorial protuberance of Saturn on the movement of the apsides. Meyer's determination of the secular variation of the line of apsides of Titan, viz $d\pi = 1726''\cdot 5$, gives the reciprocal of the mass of the ring as 26,700, but from all the six brighter satellites as 1,960; the latter value closely agreeing with Tisserand's. It does not, however, seem to have been noticed that even the smallest value for the mass considerably exceeds the highest permissible in accordance with Maxwell's result, since that would make the mass of the rings only $\frac{1}{120000}$ part of the planet's, an amount we cannot hope to detect with our present resources." (*Nature*, January 28, 1886, vol. 33: p. 303.)

Sur la Variabilité des Anneaux de Saturne.—"Observers have as yet discovered no fact that could lead them to suppose the rings of Saturn to have as a whole a rotary motion about the planet. Now if such a motion exists, it is inconceivable that it should have thus far escaped observation. But if these rings do not revolve about the planet, we cannot admit that they are solid, liquid, or even gaseous, for it is evident that such frail structures could not resist the force exercised upon them by the constantly variable attraction in the direction of the satellites. If it is true that without rotation the rings could be neither solid, liquid, nor gaseous, we must seek some explanation that shall satisfy the necessary conditions. The rings must move about the planet without there being revolution properly so called of the rings; they must be solid without being rigid. There seems to be no way of satisfying these conditions and at the same time easily explaining all the observed phenomena other than the hypothesis conceived by Cassini II and recently developed by Proctor and Clerk-Maxwell, which supposes the rings to be formed of disconnected material of thousands of little independent bodies, asteroids, circling around the planet in independent and concentric orbits not exactly in the same plane, and completing their revolutions in different times. It is evident that all the combinations necessary for explaining the observed phenomena would be possible in such a system; these bodies would explain certain phenomena in proportion as they are more or less numerous, more or less separated by space, more or less rare, &c. If we suppose (what is a very probable thing) that these bodies possess different reflective powers, we can conceive of all sorts of combinations of light, from the brilliant rings to the dark-gray bands, In short this hypothesis appears to be entirely sufficient to explain the rings of Saturn and their variability." (Trouvelot in *Bull. Astron.*, January, 1885.)

The orbit of Tethys.—"Herr Karl Bohlin has recently communicated to the Swedish Academy of Sciences an interesting discussion of the elements of the orbit of Tethys. The observations discussed are those of Sir William Herschel, 1789, reduced by Lamont; Lamont, 1836; Sir J. Herschel, 1835–'37; the Bonds, 1848–'52; Secchi, 1856; Captain Jacob, 1857–'58; Newcomb and Holden, 1874–'75, and Meyer, 1880–'81. The elements are calculated for each period of observation, without taking account of perturbations. Herr Bohlin, then specially treating the mean longitude of the epoch, and adopting 190°·69812 as the value of the mean motion, draws up tables of the differences between observation and calculation, and attemps to represent them by an empirical formula. The corrected value of the mean motion is 190°.698169, almost identical with that found previously by M. Baillaud. Herr Bohlin finds that the annual motion of the peri-saturnium amounts to 33°. M. Baillaud's results and M. Tisserand's investigations had given the value as 70°. The eccentricity is found as 0·00803 ± 0·00077." (*Nature*, January 28, 1886.)

The orbit of Iapetus.—An elaborate paper on the orbit of Iapetus, the outermost satellite of Saturn, by Prof. Asaph Hall, forms Appendix I, a quarto pamphlet of 82 pages, recently published, to the Washington Observations for 1882. Iapetus was discovered on the 25th of October, 1671, by Cassini with a telescope of 17 feet focal length. Titan, the brightest of the satellites of Saturn, was discovered by Huyghens on the 25th of March, 1655, and Huyghens was deterred, apparently, from further search by his belief that the solar system was now complete, this discovery making the number of satellites equal to the number of planets and making six* of each, which was universally admitted to be a "perfect" number. Curious variations in the brightness of the new satellite were noticed by Cassini, and his observations have been confirmed by subsequent observers. The explanation seems to be that opposite sides of the satellite have different reflecting powers, and that the satellite, in revolving around Saturn, keeps the same face always turned towards the planet. In this latter respect we have an analogous case in our moon. Professor Pickering gives the magnitude of Iapetus, from photometric measures, 11·82, and the mean diameter 486 miles.

The observations now published were, for the most part, made by Professor Hall himself with the 26-inch equatorial of the Naval Observatory, in the years 1875–'84; a few were made by Professor Newcomb in 1874. In regard to the examination of the observations for large residuals, Professor Hall remarks: "In this work no observation has been rejected. When observations have been honestly made, I dislike to enter on the process of culling them. By rejecting the large residuals the work is made to appear more accurate than it really is, and thus we fail to get the right estimate of its quality."

The adopted mean distance of Iapetus from Saturn, determined by two different methods of observing, (one by differences of right ascension and declination and the other by angles of position and distances,) which give very accordant results, is $515\cdot''5195 \pm 0\cdot''02645$; and the time for one revolution around the planet seventy-nine days, seven hours, fifty-six minutes, forty seconds. From this periodic time of the satellite and its mean distance, the mass of Saturn expressed as a fraction of the sun's mass is $\frac{1}{3481}$, or about 93·2 times the mass of the earth. Professor Hall's paper concludes with some useful tables of the satellite's motion.

URANUS: *The satellites of Uranus.*—In Appendix I to the Washington Observations for 1881 Prof. Asaph Hall has published the results of his investigations of the orbits of Uranus, "*Oberon*" and "*Titania.*" "The satellites of Uranus were amongst the first objects observed with the 26-inch refractor of the Naval Observatory, after it was mounted in November, 1873. The first series during the oppositions of 1874 and 1875 were discussed by Professor Newcomb, with the view to the determination of the mass of the planet, and the formation of tables of the motions of the satellites, which were published in the Washington Observations for 1873. Remarking that as the earth would be nearly in the plane of the orbits in the year 1882, and observations made about that year would probably afford a good determination of the position of this plane, Professor Hall commenced a new series in March, 1881, which was continued through the four oppositions to the end of May, 1884; these observations were made with magnifiers of 606 and 888; in fair conditions of the atmosphere the outer satellites are stated to be easily observable with the Washington instrument. A comparison of the measures with Professor Newcomb's tables showed that these tables required but small corrections, which were found by equations of conditions in the usual manner. It should be mentioned that the tables were founded mainly upon Professor Newcomb's own measures; these by Professor Hall in the year 1875 and 1876 are included in his recent discussion.

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* Professor Hall has called my attention to a slight error in Grant's rendering of Huyghens' remark (History of Physical Astronomy, p. 268). The discovery of Titan made the number of planets and satellites, each equal to six, and *six* (not twelve, as Grant puts it) was regarded as a "perfect" number: " - - - utrique illo, quem perfectum dicimus, numero continentur - - - " Huygenii Opera Varia, vol. 2, p. 530), a perfect number being one that is equal to the sum of all its divisors including unity.

"For the position of the nodes and inclination of the orbits of the satellites, Professor Hall finds—

$$N = 165^\circ{\cdot}81 + 0^\circ{\cdot}0142t$$
$$I = 75^\circ{\cdot}30 - 0^\circ{\cdot}0014t$$

t being the number of years from 1883.0.

"The mean value of the mass of Uranus by the observations of Oberon is $\frac{1}{22603}$, and by those of Titania $\frac{1}{22833}$, or, combining the values with their respective weights, the final result is $\frac{1}{22682}$. This value, though somewhat smaller than those previously obtained, Professor Hall thinks, is as good as he could obtain with the filar micrometer of the large refractor, and he does not consider that there would be much gained by a continuation of the measures. He mentions that during the oppositions of the planet from 1881 to 1884, which were especially favorable for the search after new satellites, he made careful examination on several good nights along the orbit plane of the known satellites without finding any new ones. The orbits of Oberon and Titania appear to be sensibly circular." (*Nature.*)

NEPTUNE: *The satellite of Neptune.*—Appendix II to the Washington Observations for 1881 contains Professor Hall's discussion of the observations of this satellite, which were made by Professor Holden and himself with the 26-inch Washington refractor: the discussion includes also observations made by Lassell and Marth at Malta in 1863 and 1864. Corrections (which come out quite small) are given for Newcomb's elements of the orbit, published in Appendix I to Washington Observations for 1873. Comparing the observations of 1881 to 1884 with those of Lassell and Marth, the periodic time is found to be 5·876839 mean solar days. Lassell's period of the satellite, which has been adopted by Newcomb, appears to be slightly erroneous. The question of the eccentricity of the orbit may be more advantageously attacked some ten or twenty years hence, when the apparent ellipse has become more nearly circular, and when there will be a better opportunity to determine this element.

The values of the mass of Neptune from Hall's measures at different oppositions, and from those of Lassell and Marth and of Holden, differ sensibly. The mean result from Hall's own observations is $\frac{1}{19092}$; he remarks that his distances are generally smaller than those of other observers, and believes that in order to eliminate the effect of such personal equation from the determination of the mass of a planet, the only way will be to increase the number of observers and to take a mean of the results. On favorable nights examinations of the region about Neptune were made, but no other satellite was detected.

Photometric observations of Neptune.—A series of observations of the planet's magnitude was carried on with the meridian photometer at Harvard College Observatory from December 16, 1884, to January 21, 1885; the resulting magnitude for mean opposition is 7·63. Professor Pickering regards it as improbable that there is any variation in the light of Neptune of a strictly periodic character.

THE TRANS-NEPTUNIAN PLANET.—In the twentieth volume of the *American Journal of Science*, page 225 *et seq.*, Prof. D. P. Todd, now of Amherst College, gave an account of his search, theoretical and practical, for the trans-Neptunian planet, made from November, 1877, to March, 1878, with the 26-inch refractor of the Washington Observatory. Professor Todd has now published* the full details of his telescopic work, giving a list of all "suspected objects," and transcribing his notebook entire.

It was expected that the planet would readily be recognized by the contrast of its disc and light with the appearance of an average star of about the thirteenth magnitude, and only approximate positions of "suspected objects" are given,—generally by means of diagrams representing the configuration of stars seen in the large telescope and in the field of the 5-inch finder. It would lighten considerably the labors of any one who may go over this ground in the future, if Professor Todd had summarized his observations in some way, by establishing the identity or non-identity of nebulous objects which he has noted, as probably to be found in Herschel's General Catalogue, and by giving a list of such objects as he was still, at the end of his work, inclined to look upon with some suspicion.

Although this search was unsuccessful, Professor Todd regards the evidence of the existence of "*the* trans-Neptune planet" as well founded, and he expresses the hope that the search may be continued with the improved methods of astronomical photography.

THE MINOR PLANETS.—During the year 1885 the number of minor planets has been increased by nine, bringing the whole number now known up to 253. The discoveries of 1885 were as follows:

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* *Proc. Am. Acad.*, 1885, 21: p. 228–43. *Astron. Nachr.*, 113: 153–66.

No.	Name.	Date of discovery.	Discoverer.	Observatory.
245	Vera	February 6	Pogson	Madras.
246	Asporina	March 6	Borrelly	Marseilles.
247	Eukrate	March 14	R. Luther	Düsseldorf.
248	Lameia	June 5	J. Palisa	Vienna.
249	Ilse	August 16	Peters	Clinton.
250	Bettina	September 3	J. Palisa	Vienna.
251	Sophia	October 4	Do	Do.
252	Clementina	October 11	Perrotin	Nice.
253	——	November 12	J. Palisa	Vienna.

The increasing difficulties in this branch of astronomical discovery are forcibly suggested by the fact that four of these bodies were first taken for planets already known and their non-identity was only established by later observations.

Number 253 was discovered while searching for Erigone, and raises the whole number of those found by Palisa to fifty. Ilse is the forty-third discovered by Professor Peters.

Of the minor planets discovered in 1884, number 237 has received the name of Cœlestina (erroneously given as Hypatia in last year's report), Number 238 that of Hypatia, 239 Adrastea, 243 Ida, and 244 Sita. Up to February, 1885, there were still 18 which had been observed at only one opposition, excepting, of course, those discovered during the year preceding.

Ephemerides of the small planets for 1886 will be found in the *Berliner Astronomisches Jahrbuch* for 1888. There are approximate places for every twentieth day, of 247 out of the 253 now known, with accurately calculated opposition ephemerides for 19 of these. The elements of these first 247 are also given.

MM. Callandreau and Fabry give in the *Bulletin Astronomique* a set of tables which will be found very useful in computing approximate ephemerides for these small bodies, when the eccentricity of the orbit does not exceed 0·407 (=sin 24°).

A series of photometric observations of Ceres and Pallas made in April and May, 1885, at Harvard College Observatory gave Ceres =7·71 magnitude with a probable error from nine observations of 0·05; Pallas =8·55 magnitude with a probable error of 0·02 from ten observations. Twenty-two observations of Vesta were made in 1880–'82, giving the result 6·47 as the magnitude of the plant for mean opposition, and the probable error 0·04. Corresponding magnitudes for a distance of unity from the sun and from the observer for these three bodies would be 4·27, 5·10, and 3·93, respectively.

Mr. A. N. Skinner, of the United States Naval Observatory, has kindly furnished the following complete list of the minor planets. The first list gives the number, name, date of discovery, and the name of the discoverer: the subscript figure to the name of the discoverer is the discoverer's number. The second list is an alphabetical index of the first 252 minor planets.

The minor planets in the order of discovery.

No.	Name.	Date.	Discoverer.
		1801.	
1	Ceres	Jan. 1	Piazzi.
		1802.	
2	Pallas	Mar. 28	Olbers$_{1}$.
		1804.	
3	Juno	Sept. 1	Harding.
		1807.	
4	Vesta	Mar. 29	Olbers$_{2}$.
		1845.	
5	Astræa	Dec. 8	Hencke$_{1}$.
		1847.	
6	Hebe	July 1	Hencke$_{2}$.
7	Iris	Aug. 13	Hind$_{1}$.
8	Flora	Oct. 18	Hind$_{2}$.
		1848.	
9	Metis	Apr. 25	Graham.
		1849.	
10	Hygeia	Apr. 12	De Gasparis$_{1}$.
		1850.	
11	Parthenope	May 11	De Gasparis$_{2}$.
12	Victoria	Sept. 13	Hind$_{3}$.
13	Egeria	Nov. 2	De Gasparis$_{3}$.
		1851.	
14	Irene	May 19	Hind$_{4}$.
15	Eunomia	July 29	De Gasparis$_{4}$.
		1852.	
16	Psyche	Mar. 17	De Gasparis$_{5}$.
17	Thetis	Apr. 17	Luther$_{1}$.
18	Melpomene	June 24	Hind$_{5}$.
19	Fortuna	Aug. 22	Hind$_{6}$.
20	Massalia	Sept. 19	De Gasparis$_{6}$.
21	Lutetia	Nov. 15	Goldschmidt$_{1}$.
22	Calliope	Nov. 16	Hind$_{7}$.
23	Thalia	Dec. 15	Hind$_{8}$.
		1853	
24	Themis	Apr. 5	De Gasparis$_{7}$.
25	Phocæa	Apr. 6	Chacornac$_{1}$.
26	Proserpina	May 5	Luther$_{2}$.
27	Euterpe	Nov. 8	Hind$_{9}$.
		1854.	
28	Bellona	Mar. 1	Luther$_{3}$.
29	Amphitrite	Mar. 1	Marth.
30	Urania	July 22	Hind$_{10}$.
31	Euphrosyne	Sept. 1	Ferguson$_{1}$.
32	Pomona	Oct. 26	Goldschmidt$_{2}$.
33	Polyhymnia	Oct. 28	Chacornac$_{2}$.
		1855.	
34	Circe	Apr. 6	Chacornac$_{3}$.
35	Leucothea	Apr. 19	Luther$_{4}$.
36	Atalante	Oct. 5	Goldschmidt$_{3}$.
37	Fides	Oct. 5	Luther$_{5}$.
		1856.	
38	Leda	Jan. 12	Chacornac$_{4}$.
39	Lætitia	Feb. 8	Chacornac$_{5}$.
40	Harmonia	Mar. 31	Goldschmidt$_{4}$.
41	Daphne	May 22	Goldschmidt$_{5}$.
42	Isis	May 23	Pogson$_{1}$.
		1857.	
43	Ariadne	Apr. 15	Pogson$_{2}$.
44	Nysa	May 27	Goldschmidt$_{6}$.
45	Eugenia	June 27	Goldschmidt$_{7}$.
46	Hestia	Aug. 16	Pogson$_{3}$.
47	Aglaja	Sept. 15	Luther$_{6}$.
48	Doris	Sept. 19	Goldschmidt$_{8}$.
49	Pales	Sept. 19	Goldschmidt$_{9}$.
50	Virginia	Oct. 4	Ferguson$_{2}$.
		1858.	
51	Nemausa	Jan. 22	Laurent.
52	Europa	Feb. 4	Goldschmidt$_{10}$.
53	Calypso	Apr. 4	Luther$_{7}$.
54	Alexandra	Sept. 10	Goldschmidt$_{11}$.
55	Pandora	Sept. 10	Searle.
		1857.	
56	Melete	Sept. 9	Goldschmidt$_{12}$.
		1859.	
57	Mnemosyne	Sept. 22	Luther$_{8}$.
		1860.	
58	Concordia	Mar. 24	Luther$_{9}$.
59	Elpis	Sept. 12	Chacornac$_{6}$.
60	Echo	Sept. 14	Ferguson$_{3}$.
61	Danaë	Sept. 9	Goldschmidt$_{13}$.
62	Erato	Sept. 14	Foerster.
		1861.	
63	Ausonia	Feb. 10	De Gasparis$_{8}$.
64	Angelina	Mar. 4	Tempel$_{1}$.
65	Cybele	Mar. 8	Tempel$_{2}$.
66	Maja	Apr. 9	Tuttle$_{1}$.
67	Asia	Apr. 17	Pogson$_{4}$.
68	Leto	Apr. 29	Luther$_{10}$.
69	Hesperia	Apr. 29	Schiaparelli.
70	Panopæa	May 5	Goldschmidt$_{14}$.
71	Niobe	Aug. 13	Luther$_{11}$.
72	Feronia	May 29	C. H. F. Peters$_{1}$.
		1862.	
73	Clytia	Apr. 7	Tuttle$_{2}$.
74	Galatea	Aug. 29	Tempel$_{3}$.
75	Eurydice	Sept. 22	Peters$_{2}$.
76	Freia	Oct. 21	D'Arrest.
77	Frigga	Nov. 12	Peters$_{3}$.
		1863.	
78	Diana	Mar. 15	Luther$_{12}$.
79	Eurynome	Sept. 14	Watson$_{1}$.
		1864.	
80	Sappho	May 2	Pogson$_{5}$.
81	Terpsichore	Sept. 30	Tempel$_{4}$.
82	Alcmene	Nov. 27	Luther$_{13}$.
		1865.	
83	Beatrix	Apr. 26	De Gasparis$_{9}$.
84	Clio	Aug. 25	Luther$_{14}$.
85	Io	Sept. 19	Peters$_{4}$.
		1866.	
86	Semele	Jan. 4	Tietjen.
87	Sylvia	May 16	Pogson$_{6}$.
88	Thisbe	June 15	Peters$_{5}$.
89	Julia	Aug. 6	Stephan.
90	Antiope	Oct. 1	Luther$_{15}$.
91	Ægina	Nov. 4	Borrelly$_{1}$.
		1867.	
92	Undina	July 7	Peters$_{6}$.
93	Minerva	Aug. 24	Watson$_{2}$.
94	Aurora	Sept. 6	Watson$_{3}$.
95	Arethusa	Nov. 23	Luther$_{16}$.
		1868.	
96	Ægle	Feb. 17	Coggia$_{1}$.
97	Clotho	Feb. 17	Tempel$_{5}$.
98	Ianthe	Apr. 18	Peters$_{7}$.
99	Dike	May 28	Borrelly$_{2}$.
100	Hecate	July 11	Watson$_{4}$.
101	Helena	Aug. 15	Watson$_{5}$.
102	Miriam	Aug. 22	Peters$_{8}$.
103	Hera	Sept. 7	Watson$_{6}$.
104	Clymene	Sept. 13	Watson$_{7}$.
105	Artemis	Sept. 16	Watson$_{8}$.
106	Dione	Oct. 10	Watson$_{9}$.
107	Camilla	Nov. 17	Pogson$_{7}$.
		1869.	
108	Hecuba	Apr. 2	Luther$_{17}$.
109	Felicitas	Oct. 9	Peters$_{9}$.
		1870.	
110	Lydia	Apr. 19	Borrelly$_{3}$.
111	Ate	Aug. 14	Peters$_{10}$.
112	Iphigenia	Sept. 19	Peters$_{11}$.
		1871.	
113	Amalthea	Mar. 12	Luther$_{18}$.
114	Cassandra	July 23	Peters$_{12}$.
115	Thyra	Aug. 6	Watson$_{10}$.
116	Sirona	Sept. 8	Peters$_{13}$.
117	Lomia	Sept. 12	Borrelly$_{4}$.
		1872.	
118	Peitho	Mar. 15	Luther$_{19}$.
119	Althæa	Apr. 3	Watson$_{11}$.
120	Lachesis	Apr. 10	Borrelly$_{5}$.
121	Hermione	May 12	Watson$_{12}$.
122	Gerda	July 31	Peters$_{14}$.
123	Brunhild	July 31	Peters$_{15}$.
124	Alceste	Aug. 23	Peters$_{16}$.
125	Liberatrix	Sept. 11	Prosper Henry$_{1}$.
126	Velleda	Nov. 5	Paul Henry$_{1}$.
127	Johanna	Nov. 5	Prosper Henry$_{2}$.
128	Nemesis	Nov. 25	Watson$_{13}$.
		1873.	
129	Antigone	Feb. 5	Peters$_{17}$.
130	Electra	Feb. 17	Peters$_{18}$.
131	Vala	May 24	Peters$_{19}$.

The minor planets in the order of discovery—Continued.

No.	Name.	Date.	Discoverer.	No.	Name.	Date.	Discoverer.
		1873.				1879.	
132	Æthra	June 13	Watson$_{14}$.	193	Ambrosia	Feb. 28	Coggia$_{3}$.
133	Cyrene	Aug. 16	Watson$_{15}$.	194	Prokne	Mar. 21	Peters$_{33}$.
134	Sophrosyne	Sept. 27	Luther$_{20}$.	195	Eurykleia	Apr. 19	Palisa$_{15}$.
		1874.		196	Philomela	May 14	Peters$_{34}$.
135	Hertha	Feb. 18	Peters$_{20}$.	197	Areto	May 21	Palisa$_{16}$.
136	Austria	Mar. 18	Palisa$_{1}$.	198	Ampella	June 13	Borrelly$_{12}$.
137	Melibœa	Apr. 21	Palisa$_{2}$.	199	Byblis	July 9	Peters$_{35}$.
138	Tolosa	May 19	Perrotin$_{1}$.	200	Dynamene	July 27	Peters$_{36}$.
139	Jnewa	Oct. 10	Watson$_{16}$.	201	Penelope	Aug. 7	Palisa$_{17}$.
140	Siwa	Oct. 13	Palisa$_{3}$.	202	Chryseis	Sept. 11	Peters$_{37}$.
		1875.		203	Pompeia	Sept. 25	Peters$_{38}$.
141	Lumen	Jan. 13	Paul Henry$_{2}$.	204	Callisto	Oct. 8	Palisa$_{18}$.
142	Polana	Jan. 28	Palisa$_{4}$.	205	Martha	Oct. 13	Palisa$_{19}$.
143	Adria	Feb. 23	Palisa$_{5}$.	206	Hersilia	Oct. 13	Peters$_{39}$.
144	Vibilia	June 3	Peters$_{21}$.	207	Hedda	Oct. 17	Palisa$_{20}$.
145	Adeona	June 3	Peters$_{22}$.	208	Lacrimosa	Oct. 21	Palisa$_{21}$.
146	Lucina	June 8	Borrelly$_{6}$.	209	Dido	Oct. 22	Peters$_{40}$.
147	Protogeneia	July 10	Schulhof.	210	Isabella	Nov. 12	Palisa$_{22}$.
148	Gallia	Aug. 7	Prosper Henry$_{3}$.	211	Isolda	Dec. 10	Palisa$_{23}$.
149	Medusa	Sept. 21	Perrotin$_{2}$.			1880.	
150	Nuwa	Oct. 18	Watson$_{17}$.	212	Medea	Feb. 6	Palisa$_{24}$.
151	Abundantia	Nov. 1	Palisa$_{6}$.	213	Lilæa	Feb. 16	Peters$_{41}$.
152	Atala	Nov. 2	Paul Henry$_{3}$.	214	Aschera	Feb. 29	Palisa$_{25}$.
153	Hilda	Nov. 2	Palisa$_{7}$.	215	Oenone	Apr. 7	Knorre$_{2}$.
154	Bertha	Nov. 4	Prosper Henry$_{4}$.	216	Cleopatra	Apr. 10	Palisa$_{26}$.
155	Scylla	Nov. 8	Palisa$_{8}$.	217	Eudora	Aug. 30	Coggia$_{4}$.
156	Xanthippe	Nov. 22	Palisa$_{9}$.	218	Bianca	Sept. 4	Palisa$_{27}$.
157	Dejanira	Dec. 1	Borrelly$_{7}$.	219	Thusnelda	Sept. 30	Palisa$_{28}$.
		1876.				1881.	
158	Coronis	Jan. 4	Knorre$_{1}$.	220	Stephania	Feb. 23	Palisa$_{29}$.
159	Æmilia	Jan. 26	Paul Henry$_{4}$.			1882.	
160	Una	Feb. 20	Peters$_{23}$.	221	Eos	Jan. 18	Palisa$_{30}$.
161	Athor	Apr. 19	Watson$_{18}$.	222	Lucia	Feb. 9	Palisa$_{31}$.
162	Laurentia	Apr. 21	Prosper Henry$_{5}$.	223	Rosa	Mar. 9	Palisa$_{32}$.
163	Erigone	Apr. 26	Perrotin$_{3}$.	224	Oceana	Mar. 30	Palisa$_{33}$.
164	Eva	July 12	Paul Henry$_{5}$.	225	Henrietta	Apr. 19	Palisa$_{34}$.
165	Loreley	Aug. 9	Peters$_{24}$.	226	Weringia	July 19	Palisa$_{35}$.
166	Rhodope	Aug. 15	Peters$_{25}$.	227	Philosophia	Aug. 12	Paul Henry$_{7}$.
167	Urda	Aug. 28	Peters$_{26}$.	228	Agathe	Aug. 19	Palisa$_{36}$.
168	Sibylla	Sept. 28	Watson$_{19}$.	229	Adelinda	Aug. 22	Palisa$_{37}$.
169	Zelia	Sept. 28	Prosper Henry$_{6}$.	230	Athamantis	Sept. 3	De Ball.$_{1}$
		1877.		231	Vindobona	Sept. 10	Palisa$_{38}$.
170	Maria	Jan. 10	Perrotin$_{4}$.			1883.	
171	Ophelia	Jan. 13	Borrelly$_{8}$.	232	Russia	Jan. 31	Palisa$_{39}$.
172	Baucis	Feb. 5	Borrelly$_{9}$.	233	Asterope	May 11	Borrelly$_{12}$.
173	Ino	Aug. 1	Borrelly$_{10}$.	234	Barbara	Aug. 12	Peters$_{42}$.
174	Phædra	Sept. 2	Watson$_{20}$.	235	Carolina	Nov. 28	Palisa$_{40}$.
175	Andromache	Oct. 1	Watson$_{21}$.			1884.	
176	Idunna	Oct. 14	Peters$_{27}$.	236	Honoria	Apr. 26	Palisa$_{41}$.
177	Irma	Nov. 5	Paul Henry$_{6}$.	237	Cœlestina	June 27	Palisa$_{42}$.
178	Belisana	Nov. 6	Palisa$_{10}$.	238	Hypatia	July 1	Knorre$_{3}$.
179	Clytemnestra	Nov. 11	Watson$_{22}$.	239	Adrastea	Aug. 18	Palisa$_{43}$.
		1878.		240	Vanadis	Aug. 27	Borrelly$_{13}$.
180	Garumna	Jan. 29	Perrotin$_{5}$.	241	Germania	Sept. 12	Luther$_{21}$.
181	Eucharis	Feb. 2	Cottenot.	242	Kriemhild	Sept. 22	Palisa$_{44}$.
182	Elsa	Feb. 7	Palisa$_{11}$.	243	Ida	Sept. 29	Palisa$_{45}$.
183	Istria	Feb. 8	Palisa$_{12}$.	244	Sita	Oct. 14	Palisa$_{46}$.
184	Dejopeja	Feb. 28	Palisa$_{13}$.			1885.	
185	Eunike	Mar. 1	Peters$_{28}$.	245	Vera	Feb. 6	Pogson$_{8}$.
186	Celuta	Apr. 6	Prosper Henry$_{7}$.	246	Asporina	Mar. 6	Borrelly$_{14}$.
187	Lamberta	Apr. 11	Coggia$_{2}$.	247	Eukrate	Mar. 14	Luther$_{22}$.
188	Menippe	June 18	Peters$_{29}$.	248	Lameia	June 5	Palisa$_{47}$.
189	Phthia	Sept. 9	Peters$_{30}$.	249	Ilse	Aug. 16	Peters$_{43}$.
190	Ismene	Sept. 22	Peters$_{31}$.	250	Bettina	Sept. 3	Palisa$_{48}$.
191	Kolga	Sept. 30	Peters$_{32}$.	251	Sophia	Oct. 4	Palisa$_{49}$.
		1879.		252	Clementina	Oct. 11	Perrotin$_{6}$.
192	Nausicaä	Feb. 17	Palisa$_{14}$.	253	————	Nov. 12	Palisa$_{50}$.

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REPORTS OF OBSERVATORIES.

The following account of the recent activity of astronomical observatories has been derived from the "Jahresberichte der Sternwarte für 1884," in the *Vierteljahrsschrift der Astronomischen Gesellschaft*, volume 20 (a condensed translation of this appeared in the *Sidereal Messenger*, September, 1885), and from the reports of observatories for 1885 that have been published up to the present date (April, 1885): the reports of English observatories are largely obtained from the *Monthly Notices*. *Sirius* XIX: 14–18, 64–66) contains brief descriptions, &c., of Austro-Hungarian observatories.

Armagh.—The building for the new 10-inch Grubb equatorial (10 feet focal length) was erected in July last. The dome moves on 6 "canted" wheels and is covered with papier-mâché riveted to the iron framework and stitched together with copper wire. The declination circle can be read from the eye end, and both it and the right ascension circle can be illuminated by small incandescent lamps worked by a two-cell bichromate battery.

Bamberg Observatory.—Dr. Hartwig, recently of the Strassburg and Dorpat observatories, has been appointed director (January, 1886), and is busy with the preliminary arrangements for erecting the buildings.

Berlin (1884).—The large meridian circle has been dismounted and has received important mechanical improvements. The observations on the southern half of the Berlin Zone were temporarily stopped during the year. Dr. Kuestner has begun a series of observations with the object of determining the constant of aberration by measures of the difference of zenith distances of pairs of stars in the same R. A. and equal and opposite Z. D. The work is to be finished in 1885. Dr. Knorre has made a large number of observations with the 9·6-inch equatorial for the positions of asteroids, comets, and faint stars. The planet *Hypatia* was found by him July 1, 1884. Dr. Battermann is regularly observing occultations, both immersions and emersions. Dr. Marcuse has charge of the heliometer, and has made thirty-three determinations of the solar diameter, &c. Vol. v of the Berlin observations has been published during the year.

German Transit of Venus Commission (1884). The report of Dr. Auwers on the work of the computing bureau relates first to the *observations*. These are of three kinds: (1) Observations before the expeditions, for practice, and for the investigation of special points; (2) observations at the stations; and (3) observations made after the return of the parties. A list of the heliometer measures of each observer comprised in these classes is given separately, and a summary, from which it appears that the total number of complete measures with the four heliometers was:

Before and after the expeditions	1,769
At the stations themselves	1,074
In all, for thirteen observers	2,843

Bermerside, Halifax (Mr. Edward Crossley's observatory). Phenomena of the satellites of Jupiter and Saturn observed.

Bonn.—2881 zone stars (four hundred fundamental stars) were determined in the A. G. zone. The southern *Durchmusterung* has required the examination of some seven hundred and fifty places in the sky to solve doubts. In December, 1883, the charting of the stars on the maps was again begun and finally completed in March, 1885. The catalogue will contain 133,658 stars between — 2° and — 23°; 692 more are given north of these limits and 479 south.

Bordeaux.—This observatory, founded in 1871, has just now (*Comptes Rendus*, 101 : 690, 1885), published its first volume of *Annales*, containing a minute description of the instruments (a meridian circle of 0·19^m aperture, two equatorials of 0·22 and 0·39^m, and three clocks), and, also, a determination of the longitude of the observatory. An important piece of work has been undertaken by the director, M. Rayet, in the re-observation of the 23,000 stars in Argelander's southern zones, between — 15° and — 31° of declination. The latitude is given as +44° 50′ 7″·23. (*Science.*)

Boswell Observatory, of Doane College, Crete, Nebr., is due to the liberality of the late Charles Boswell, of West Hartford, Conn. The observatory possesses a full set of meteorological instruments in addition to its astronomical equipment, and is a signal-service station, co-operating with the United States Signal Service at Washington. A time-ball is dropped daily at noon.

Brussels.—The transit and mural are used to observe moon culminating stars. A general catalogue of the stars observed at Brussels in the years 1857–'78, reduced to 1865, will be printed during 1885. M. F. Folie, administrating inspector of the University of Liège, has been appointed director. Since the resignation of M. Houzeau, the direction has been in the hands of a committee of three, MM. Stas, Liagre, and Mailly.

Buchtel College Observatory, Akron, Ohio.—Approximate latitude, +41° 3′; approximate longitude, 5^h 26^m west of Greenwich. The observatory was erected in the summer of 1885, and the instruments set up about March 1, 1886. The following instruments are in use:

Transit circle of 3 inches aperture, by Fauth & Co., of Washington. The circles are 16 inches in diameter, one being coarsely divided on the edge and serving as a finder, the other being divided on silver to five-minute spaces and reading by two micrometer-microscopes to single seconds. The telescope is provided with right ascension and declination micrometers. A fine level is attached, so that the instrument can be used as a zenith telescope; reversing apparatus, plain and diagonal eye-pieces accompany the instrument.

Sidereal clock, by E. Howard & Co., of Boston. This clock is provided with electrical attachments for operating the chronograph. Chronograph, by Fauth & Co. Mean time clock, by Fauth & Co. This clock is provided with Gardner's electrical attachments for operating chronograph, dropping timeball, and correcting a system of controlled clocks.

Equatorial telescope of 4½ inches aperture, by Pike & Sons.

Sextant, by Fauth & Co.

The observatory was built as a working observatory for the college students in astronomy, and it will be chiefly devoted to this purpose. Besides this, the work for the following year will be, (1) to furnish the city and surrounding towns with correct time signals; (2) to determine the latitude and longitude; (3) to observe all occultations of stars that are visible here.

Cambridge (*England*) *Observatory.*—The total number of observations made with the transit circle during the year was 3,253, including 2,442 observations of zone stars made on one hundred nights. The observations of clock stars and those of Polaris are completely reduced, and the mean places for January 1 obtained up to the end of 1884. The true apparent places of all other stars observed in 1884 are also obtained, both in R. A. and N. P. D.

Christiania.—An equatorial of 360^{mm} aperture and $6{\cdot}8^{m}$ focal length has been erected by Herr H. G. Olsen. (*Sirius.*)

Cincinnati Observatory.—No. 8 of the publications of this observatory, containing the observations of comets in 1883, has appeared during the past year (1885). "It is noteworthy as presenting a pretty complete report on the phenomena of Pons' periodical comet of 1812 at its reappearance. The features of the tail were particularly studied, and the discussion of the observations, based upon the theory of Dr. Bredichin, has been found to add confirmation to that theory." These observations were made by Mr. H. C. Wilson while in temporary charge. The observatory is now under the direction of Prof. J. G. Porter.

Constantinople.—It is reported that the Sultan has ordered the erection of an astronomical and meteorological observatory at Constantinople.

Cordoba Observatory.—Dr. B. A. Gould returned to the United States in April, 1885. He has been succeeded as director of the Cordoba Observatory by his first assistant, Dr. John M. Thome. Dr. Gould has published as the final definitive position of the Cordoba meridian circle: Latitude, $-31^{\circ}\,25'\,15''{\cdot}46$; longitude, $4^{h}\,16^{m}\,48^{s}{\cdot}2$ west of Greenwich.

Dearborn Observatory.—Professor Hough's report for the year ending May 20, 1885, states that the meridian circle has been used for determination of time, which is furnished daily to the city of Chicago. A full description is given of a printing chronograph. The work with the great equatorial has been confined mainly to difficult double stars and the planet Jupiter. Four sketches of Jupiter accompany the report. The partial eclipse of the sun of March 16 was observed for last contact, and a number of dry-plate negatives were obtained.

Denmore Observatory (1885).—Mr. W. H. Numsen has erected a small private observatory near the city of Baltimore, and his 4-inch Cooke equatorial has been devoted to the study of the physical features of comets, &c. The approximate position of the observatory is, latitude +39° 21′; longitude 5^h 6^m 52^s west of Greenwich.

Dresden (1884) (private observatory of Baron Engelhardt).—two hundred and forty-two observations of the positions of comets, planets, and nebulæ (198) have been made with the 12-inch equatorial, besides minor observations.

Dun-Echt Observatory (1885).—Lord Crawford has published Vol. III, containing Division II, of the account of the Mauritius expedition to observe the transit of Venus, 1884. The Dun-Echt circulars have proved themselves invaluable during the year.

Dunsink.—The South equatorial has been employed as usual in observations on stellar parallax. The list of southern stars mentioned in former reports, observed with the meridian circle, has been supplemented by a list of proper motion stars.

Düsseldorf (1884).—Professor Luther discovered planet 241, Germania, during the year on his Berlin chart for 0 hours. Since 1847, 150 planets have been observed 1,233 times at Dusseldorff with the 6-inch telescope.

Ealing (Mr. Common's observatory).—Experiments in astronomical photography. Comet 1885 III, independently discovered on September 4.

Edinburgh.—The printing of the Edinburgh Star Catalogue and Ephemeris for 1830 to 1890 has been resumed, and it is now completed to 17^h right ascension.

Frankfort-on-the-Main (1884) (private observatory of Herr Eppstein).—The star gauges were continued on sixty-two nights, in 682 places, 2,714 fields, containing 25,875 stars.

Sun-spots are also regularly observed here.

Geneva (1884).—The large equatorial has been provided with a spectroscope. Besides the regular observations relating to meteorology and to chronometers, observations of comets and of the satellites of Saturn have been made.

Glasgow.—Astronomical observations during 1885 have been necessarily confined to observations of a select list of stars with the transit circle. The meteorological department has finally been put upon a satisfactory footing.

Gotha (1884).—The computations of the zone 20° to 25° of the A. G. have been prosecuted. The meridian circle is used to observe moon culminating stars and others of Mayer's Catalogue, the equatorial for planet and comet observations.

Greenwich Observatory.—The last report of the astronomer royal is for the year ending May 20, 1885, and is one of the most interesting that has appeared for several years. Transit circle: A reversion prism has been used in all observations; a comparison of the results from the reversed and ordinary observations of clock stars shows sensible differences in the case of some observers, who, perhaps, have not settled down to a fixed habit of observing "reversed" stars. For determining absolute personal equations in observations of stars and of limbs of the sun, moon, or planets, a personal equation apparatus consisting of a vertical plate, with a circular aperture 6 inches in diameter to represent the sun or moon and several small pinholes to represent stars, is placed in the focus of an object-glass of about 7 inches aperture and 50 feet focal length (which is attached to the dew-cap of the transit circle when horizontal and pointing north), and is carried smoothly by clock-work. The times of transit of the artificial objects are observed over the wires of the transit circle, and are also automatically recorded on the chronograph.

The sun, moon, planets, and fundamental stars have been observed regularly. The annual catalogue for 1884 contains about 1,370 stars.

The altazimuth has been used in observing the moon from last quarter to first quarter in each lunation.

For the determination of motions of stars in the line of sight 569 measures have been made of the displacement of the F line in the spectra of 47 stars, and 72 measures of the *b* lines in 14 stars. The observations of the last twelve months confirm the change in the motion of Sirius, which now appears to be approaching the sun at the rate of about 20 miles a second.

Photographs of the sun were taken on one hundred and seventy-three days. On only two days was the sun's disk observed to be free from spots.

In conclusion, Mr. Christie strongly urges an appropriation for an object-glass of 28 inches aperture and 28 feet focal length, to be placed upon the southeast equatorial mounting, in place of the present objective of less than half that aperture. This increased optical power is especially desired for prosecuting the spectroscopic work.

We understand that the necessary sum has been granted, and that Mr. Grubb is already at work upon the glass.

Grignon (1884) has made various observations on solar spots, comets, meteors, lunar eclipses, spots on Venus and Mars, &c., for which observations, and the conclusions drawn from them, reference must be made to the original report.

Harrow (Lieutenant-Colonel Tupman's observatory).—The meridian circle has been employed in determining the latitude and longitude of the observatory, and in observing right ascensions of the moon. The approximate latitude found is +51° 34′ 47″, and the approximate longitude, from transporting chronometers, $1^{m}\ 19^{s}{\cdot}9$ west of Greenwich. The equatorial reflector has been chiefly used for observations of comets.

Harvard College Observatory.—Professor Pickering's report was presented to the visiting committee December 3, 1885. The death of Mr. Robert Treat Paine has deprived the observatory of the immediate aid and advice of one of its most cordial friends, who had been a member of the visiting committee from the time of its original organization, forty years ago. Mr. Paine has perpetuated his services to his favorite science by the bequest to the observatory of his entire fortune, amounting to more than a quarter of a million of dollars. Upon the settlement of the estate, one-half of this sum will become immediately available.

The devotion of the observatory mainly to photometry continues, and the large equatorial has been occupied in observations of the eclipses of Jupiter's satellites, faint stars selected as standards of magnitude, comparison stars for variables, and of the temporary star in the nebula of Andromeda. Mr. Chandler has continued his observations with the new instrument of his invention called the *almucantar*, which in his hands exhibits, Professor Pickering says, a surprising efficiency and accuracy. The meridian photometer shows a large increase of work over previous years, the number of separate settings somewhat exceeding 50,000. The list of objects observed has been somewhat extended, and the accordance of the results continues satisfactory. The height and velocity of clouds have been the subject of study with Mr. W. M. Davis, about three hundred series of measures being obtained at a pair of stations connected by telephone. The measured altitudes varied from 2,000 to 25,000 feet. The observatory remains the American center of telegraphic distribution of important astronomical announcements, the discovery of nine small planets, five comets, and one new star being promulgated during the year. By the aid of the Bache fund of the National Academy of Sciences, an important investigation in stellar photography has been undertaken. Many photographs of the trails left by stars have been taken with the camera stationary; and an equatorial star no brighter than the sixth magnitude leaves its mark in this way, while stars much fainter near the pole will leave an impression, since their motion is slow. Stars as faint as the fourteenth magnitude have thus been photographed without clock-work to move the instrument. The trails of the faint polar stars are very well defined and minute, and afford an excellent measure of stellar brightness, besides furnishing the means of determining the stars' positions with great accuracy. Also, the attempt has been made to prepare star charts by photography; but the most striking results have been obtained with stellar spectra. By means of a large prism mounted in front of the lens, photographs of spectra have been obtained of stars as faint as the eighth magnitude, in which lines are shown with sufficient distinctness to be clearly seen in a paper positive. As all the stars in a large region are thus obtained with one exposure, more than a hundred spectra have been secured on a single plate.

The work done with the meridian circle by Professor Rogers has largely consisted in the determination of the graduation of the instrument. The work performed for this purpose is equivalent to the reading of a microscope forty thousand times. A second revision of the zone observations between the declinations +50° and +55° is nearly completed, and the observation of a catalogue of circumpolar stars has made good progress. Many shorter series of observations have also been made. The reductions are far advanced, and material for several volumes is nearly ready for the press.

An abstract of Mr. Chandler's investigation of the latitude of the Havard Observatory in given below:

During the past winter a number of stars situated between +5° and −5° of declination were observed with the almucantar (see *Bulletin Astronomique* I, p. 37), for the purpose of a new determination of the latitude of the observatory. The observations of this winter, confirmed by a new discussion of former determinations, indicate that the latitude of the dome of the Havard College Observatory, as given in the *American Ephemeris* (42° 22′ 48″·3), or in the *Connaissance des Temps* (48″·1), is much too large. The more correct value, according to Mr. Chandler, is 42° 22′ 47″·6.

For the latitude in question, there are on hand Professor Peirce's determination, based upon a long series of observations by the Messrs. Bond (1844–'45, prime vertical transits); Dr. Gould's determination (1855, zenith telescope); a series of observations by Professor Rogers (1864, prime vertical transits) not yet published; and, finally, two series obtained by Mr. Chandler in 1883, with a small almucantar and with a portable transit instrument. We give here the collected results of these different determinations, which are quite sensibly modified by reduction to the system of Dr. Auwer's fundamental catalogue. The results of 1844, which depend upon five stars only, are much more accordant with the other results if the observations of β Persei be omitted in the reduction, β Persei giving a latitude 1″·5 less than the general mean. Mr. Chandler thinks that this star's proper motion in declination as adopted by Dr. Auwers (+0″·01) should be corrected by (− 0″·03).

	No. of observations.	Latitude.	Reduced to Auwer's system.
		° ′ ″	″
Bond-Peirce	168	42 22 48. 13	47. 06
Bond-Peirce (excluding β Persei)	128	48. 17	47. 53
Gould	308	48. 15	47. 61
Chandler, 1883	18	47. 63	47. 63
Do	28	47. 59	47. 45
Do	85	47. 57	47. 57

Bull. Astron., August, 1885.

Helsingfors.—Dr. Anders Donner was appointed director to succeed Professor Krueger in 1883. The meridian instrument has been used to reobserve some 500 stars of the Helsingfors zone, +55° to +65°, Victoria and Sappho, the Moon and moon-culminating stars, &c.

Herény.—Vol. II will be published in 1885. Spectrum observations of β Lyræ have confirmed the variability of the spectrum of this star. Many other spectroscopic observations of stars, planets, and comets have been made.

Hong Kong.—Largely devoted to meteorological observations, weather reports, &c. The new time-ball was dropped daily at 1 P. M., Sundays and holidays excepted. Observations of the moon and of Jupiter's satellites have been obtained.

Karlsruhe (1884).—The principal work of the observatory is the determination of the positions of southern stars to 8th magnitude, inclusive. In the zone 0° to $-4°$, 5,000 observations have been made, and the zone $-4°$ to $-7°$ has been commenced. The single positions have probable errors of $\pm 0^{s}\cdot028$ and $\pm 0''\cdot39$. The 6-inch refractor has been remounted.

Kew.—Sketches of sun-spots have been made on one hundred and seventy-six days, in order to continue Schwabe's enumeration. The rating of time-pieces and the examination of sextants, meteorological instruments, &c., is continued.

Kiel (1884).—The equatorial has been used to observe Σ 2164 for parallax, by Dr. Lamp. New comets were regularly observed. The meridian circle is used to determine the positions of stars between 79° and 82° north. The zone catalogue (55° to 65°) is in preparation.

Leipzig (1884).—A 6-inch heliometer by Repsold is in process of construction and will be delivered at the end of 1886. A universal instrument has been ordered, with which a long series for latitude will be commenced. Ten thousand five hundred and forty-one observations (123 zones) of zone stars have been made in the new zone ($+5°$ to $+10°$) and the reductions for the old zone ($+10°$ to $+15°$) are in progress.

Leipzig (1884) (private observatory of Dr. Engelmann).—Two thousand six hundred observations of 430 double stars have been made, mostly of Struve's doubles. An investigation of the constant errors is in progress. It appears that the *difference* in the magnitude of the components influenced the *constant* errors in a marked degree. Otto Struve's list of double stars for comparison has been observed; about 500 measures have been obtained.

Leyton (Mr. Barclay's observatory).—Double-star observations and observations of the phenomena of the satellites of Jupiter and Saturn are continued.

Lick Observatory.—All the buildings for the observatory proper are now completed except the dome for the large equatorial. A suitable dwelling house has been erected; others will be required. All the principal instruments of the observatory but one have been designed, ordered, constructed, inspected, and are now suitably mounted, so that observations could be at once begun. This instrumental equipment consists of a 12-inch Clark equatorial; a Repsold meridian circle of essentially the same design as the Strasburg instrument, having an object glass of 6 inches aperture, with collimators of the same size (these three objectives by Alvan Clark & Sons); a 4-inch transit instrument by Fauth; a 6-inch equatorial; a 4-inch comet-seeker by Clark; a 2-inch Repsold vertical circle; a photo-heliograph; a measuring engine by Stackpole, reading either rectangular or polar co-ordinates. There are five clocks, by Dent, Frodsham, Hohwü, and Howard, and four chronometers by Negus. A system of electrical connections unites all the clocks and observing rooms. A most wise provision is a workshop with a complete outfit of tools and lathes. An extensive library is in process of formation and has already necessitated an outlay of about $5,000.

The contract for the object glass of the great refractor, which is to have an aperture of 36 inches and a focal length of 60 feet, was placed with the Messrs. Clark nearly five years ago. Two years later they received from the glass-maker, M. Feil, of Paris, a disk of flint-glass of the required perfection, and 38 inches in diameter. After repeated unsuccessful attempts a satisfactory piece of crown-glass was cast in 1885, and sent to the Clarks, and about October the work of figuring was begun, and is now being pushed rapidly forward. The Clarks hope to have the objective finished in the autumn of 1886. It has not yet been decided, we believe, who is to make the elaborate mounting for the telescope, or the dome of about 70 feet diameter, which is to cover it.

"With regard to the prospective capabilities of the great telescope when placed in so favorable an atmosphere, it is stated that it is not unreasonable to suppose that on the best nights the maximum magnifying power (about 3,500) may be advantageously employed. Making due allowance for the unfavorable effects of the earth's atmosphere, the observer might, under these circumstances, expect to see the moon much the same as he would without the telescope, if it were only 100 miles away. It might be possible then to make out details of objects, even although they were no larger than some of the larger edifices on the earth."

Prof. Edward S. Holden, director of the Washburn Observatory, Madison, was appointed January 1, 1886, to the double position of director of the Lick Observatory and president of the University of California, to which latter institution the observatory when completed will be attached. Professor Holden, as consulting astronomer, has virtually had the direction of the work for some time past, visiting Mount Hamilton in 1881 and again in 1883 and 1884.

The first volume of the publications of the Lick Observatory is now in course of preparation, under the direction of the Lick trustees, by Capt. Richard S. Floyd and Professor Holden.

Liverpool Observatory.—Time-service and chronometer tests are continued as in previous years. The late Mr. John Hartnup was succeeded as director by his son, who bears the same name.

Lund (1884).—Dr. Dunér continues his observations of the spectra of stars, measures of double stars, and positions of the comets. The longitude observations of Dr. Dunér and Professor Thiele in 1879, lately reduced, make the Lund Observatory $2^{m}\ 26^{s}{\cdot}38 \pm 0^{s}{\cdot}04$ east of the observatory of Copenhagen.

McCormick Observatory.—The Leander McCormick Observatory, of the University of Virginia, was formally opened by public ceremony on the 13th of April, 1885. An address on "The instruments and work of Astronomy," was made by Professor Hall, of the United States Naval Observatory.

The 66^{cm} (25·98 inches) equatorial of the observatory is chiefly employed at present in observations of nebulæ. During the progress of this work something over two hundred new nebulæ have thus far been detected by Professor Stone and his assistant, Mr. Leavenworth. Drawings of about the same number of nebulæ (some old and some new) have also been made. Professor Stone designs making a special study of the nebula of Orion.

McKim Observatory.—The McKim Observatory was opened in September, 1885, as a department of De Pauw University. It is located in the suburbs of the university town, Greencastle, Ind., in west longitude from Greenwich 86° 37½′, north latitude 39° 37′. The building and the full instrumental experiment which it is designed to have are the gift of Mr. Robert McKim, of Madison, Ind. This gentleman has for a number of years had a 6-inch glass mounted near his residence, so that the observatory he has just presented to De Pauw University might almost be called the *second* McKim Observatory.

The equatorial has a clear aperture of 9·53 inches; the dome is of iron, and is 17 feet in diameter. Both telescope and dome are by Warner and Swasey, of Cleveland. For clock errors an almucantar is to be used. The building and instruments have cost $8,000, and about $2,000 more will be expended. Dr. T. P. John is the director.

Madras.—From the report for 1883 we learn that 2,453 observations were made with the meridian circle during the year, making a total of 50,878 Only a few hundred more are required to finish the catalogue of over 5,000 stars. The publications are badly behindhand.

Melbourne.—Mr. Ellery's nineteenth annual report states that the new transit circle of 8 inches aperture was received in May, 1884, and mounted early in July. It is proposed to send the two specula of the great reflector, one after the other, to England to be repolished. A number of stars selected by Auwers was observed with the old transit circle to assist in the formation of a fundamental catalogue of southern stars.

Mexico Observatory.—Prof. H. S. Pritchett, director of the observatory of the Washington University at Saint Louis, kindly communicates the results of a longitude campaign between his observatory and the Observatorio Nacional de Mexico, Sr. A. Anguiano, director. A preliminary discussion gives $35^{m}\ 57^{s}.25$ as the difference of longitude, or $6^{h}\ 36^{m}\ 46^{s}.41$ west of Greenwich as the resulting longitude of the transit-circle piers of the Mexican observatory. This differs $5^{s}.0$ from the old value determined by moon-culminations. The circuit was 2,583 miles long, with five repeaters, and the armature time was quite constant, averaging $0^{s}.38$. The outfit of the Mexican National Observatory includes a 15-inch equatorial by Grubb, and an 8-inch meridian circle and a 6-inch transit, both by Troughton and Simms. The *personnel* consists of the director (Sr. Anguiano) and five assistants. (*Science*, November 6, 1885.)

Milan (1884).—The 8-inch refractor has been used for measurements of 255 double stars and for observations of comets. The measures of the ellipticity of Uranus cannot yet be considered free from all objections. The observations on Mars seem to confirm previous results as to the duplication of canals, &c.

The large dome for the 18-inch refactor is nearly completed.

Munich (1884).—The 10-inch equatorial is now remounted and the Repsold micrometer has been studied. It will be principally used to determine the parallaxes of Ll. 28298, 26 Draconis, Gr. 2875, Br. 3077.

The Munich zones contain 34,000 stars, of which 9,800 require reobservation. This will be accomplished in zones 6° broad. The old Munich zones are recomputed and a catalogue (for 1880) is in preparation.

Natal Observatory (1884).—Fifty-nine transits of the moon's limb and 50 transits of the nearly central crater Murchison A have been obtained with the transit circle. These observations furnish data for calculating the variation in the irradiation at the edge of the moon and of the effect of the known irregularities on the limb. Arkley Observatory, England, co-operates in this work. An appendix to the report contains observations of comets Pons and Barnard.

Nice.—The observatory and its extensive grounds occupy the summit of a hill known as Mont Gras, some 1,200 feet above sea level and distant from the Mediterranean about 3 or 4 miles. We notice that it is arranged on the plan of detached buildings, a plan that has been followed in the construction of most large observatories of recent date. On the southern slope of the hill are the dwelling houses for the observers, library, computing rooms, &c., and higher up are the various buildings that contain the instruments. A 15-inch equatorial, 6-inch meridian circle, and 3-inch transit are already in use. The great steel dome, 72 feet in diameter, is finished and has been found to work satisfactorily. The peculiarity in the construction of this dome—the work of the celebrated engineer Eiffel, of Paris—is that the greater part of its weight is taken by a circular float which revolves in an annular tank filled with a solution of chloride of magnesium in water. This solution has a density of 1·25, and is able to resist a temperature of 40°

centigrade below zero. Running-wheels are used as guides and to take such a share of the superimposed weight only as may be necessary to secure perfect steadiness in rotation. It is evident that by adding to the water in the tank the weight on the wheels can be either entirely or partially relieved, and by abstracting from it, any desired pressure can be placed upon these wheels. The shutter is made in two leaves, and opens right and left with a rain-tight joint in the center; the opening is about 10 feet. For a complete description of the dome, with illustrations, we must refer to *L'Astronomie*, 4 : 206–12; *Observatory*, 8 : 290; and *Nature*, 32 : 62, 297.

M. Faye announces that the objective of 30 inches clear aperture has been finished by the Henry brothers, and has been sent to Gautier, who has charge of the construction of the great equatorial; it is hoped the instrument will be mounted in April, 1886.

O'Gyalla.—Sixteen hundred and ten observations for the spectroscopic *Durchmusterung* of the southern sky have been made. Color observations with the Zoellner photometer are also continued, as well as various other photometric and spectroscopic series.

Oxford University Observatory.—The director's annual report was read on June 3, 1885. A subsidiary observatory, for instruction, has been built. Professor Pritchard has published a memoir on the evidences of mutual gravitation among the components of the Pleiades. The completion is announced of the phometric survey of all stars visible to the naked eye from the pole to —10°.

Paris.—Rear-Admiral Mouchez has issued his report on the work of this establishment during the year 1884. The completion of the reobservation of Lalande's stars has led to a new disposition of the meridian instruments, one of which, on the proposal of M. Lœwy, is now occupied with the determination of a number of circumpolar stars on his new method; the great meridian circle and the circle of Gambey are still employed for observations of the minor planets and of comparison stars for planets, comets, and nebulæ observed with the equatorials. The great telescope of $0^{m}\cdot74$ is still unmounted, no suitable position being available in the present state of the grounds of the observatory. M. Mouchez mentions having received communications from the authorities in Algeria, referring to the possibility of obtaining from the local budget the greater part of the sum that would be required to mount the instrument at the observatory of Algiers on the summit of the Boudjaréah, an exceptionally favorable situation, which might be visited by the astronomers of the Paris Observatory for special observations, but the council of the latter institution have not availed themselves of the proposition, in the hope that the equatorial may yet be erected at Paris. Amongst the observations made with the instruments in the west tower and the Henry equatorial are many of the satellites of Uranus and Neptune, the companion of Sirius, the belts of Uranus, nebulæ, and double stars. MM. Henry have been occupied with astronomical photography during the year, and, as is well known, with great success; various clusters of stars have been photographed, and M. Mouchez appends to his report a reproduction by heliogravure of a plate of the great clusters in Perseus. A trace of the motion of the minor planet Pallas was shown after an exposure of thirty-five minutes. The important results obtained by MM. Henry in photographing very small stars in those crowded parts of the heavens where the galaxy crosses the ecliptic have been already referred to. - - - Steady progress has been made, both with the calculations and printing of the Paris Catalogue of Stars, and it is expected that the first volume of both series (star positions as observed, and catalogue) will be completed by the end of the year. Vol. 18 of the *Mémoires* is finished. The report further details the personal work of the members of the observatory staff. Amongst the additions to the museum is a portrait of Pons, presented by M. Tempel.

The report for the year 1884 is preceded by one which enters specially into the present condition of a scheme for removing the principal instruments in the observatory to a site where not only greater steadiness can be secured in their mounting, but where the objections of being surrounded by a great city will not exist. It appears that the Academy of Sciences have not, so far, favored this scheme. M. Mouchez states very clearly his view of the question. (*Nature.*)

Potsdam.—Researches are in progress on a new determination of the wave-lengths of a large number (300) of the Fraunhofer lines; on the influence of temperature on the refraction and dispersion indices of fixed substances; on the reflective power of various substances; on the absorption-spectra of such substances as are used in photography, &c.

Jupiter and Mars were regularly observed and the nebulæ observations are concluded.

The photometric measures embraced long series of determinations of the brightness of the major planets and of seven of the asteroids. Many variable and red stars were also measured. Determinations of the brightness of stars by photography have also been made, and a number of photographs of clusters have been taken.

"The first part of the fourth volume of the publications of this observatory, which was published in the latter part of last year [1885] contains three papers. The first of these is by Professor Vogel, and contains the observations which he made with the great Vienna reflector in 1883 for the purpose of testing the performance of the great object-glass. Professor Vogel's final verdict is altogether favorable. 'The Vienna objective,' he says, 'leaves nothing to be desired as regards the precision of the images,' and he speaks of using with advantage a power even of 1,500 upon planetary markings, a statement which is illustrated by a sketch of part of Saturn's ring as seen with that magnifying power.

His principal observations were, however, spectroscopic, Professor Vogel utilizing the great light-gathering power of the Vienna equatorial for a detailed examination of the remarkable spectra shown by several faint stars, classified by him under Types II *b* and III *b*. - - - The paper also contains a number of observations of nebulæ, principally planetary, and is illustrated by four lithographic plates. The second paper contains meteorological observations made in the years 1881 to 1883, and the third is a very careful investigation by Dr. G. Müller of the influence of temperature on the refraction of light through prisms of various kinds of glass, of Iceland spar and rock crystal." (*Nature.*)

Prague (private observatory of Professor Safarik).—Fourteen hundred and eighty-two observations of 92 stars were made in 121 observing nights.

Pulkowa Observatory.—"We have received M. Struve's annual report, presented May 25, 1885, on the work of the observatory during the year. The great 30-inch refractor had not yet been brought regularly into use; but at the time of writing the report observations with it were to be commenced immediately. The observations with the 15-inch equatorial, which for the last forty-five years have been M. O. Struve's own special work, are now undertaken by his son, Hermann Sturve, as he himself has been too much occupied with other work, as well as having been incapacitated by a long illness. Micrometrical measures (98 in all) of the relative positions of Iapetus and Titan, Titan and Rhea, and Rhea and Dione have been made during the year. It is hoped that these measures, in combination with those made in former years, will furnish very accurate elements of the orbits of these satellites. Dr. Hermann Struve has also made observations for determination of the parallaxes of 10 stars, as well as determinations of the positions of Encke's and Wolf's comets. The relative positions of 116 faint stars, which were occulted by the moon during the total eclipse of October 4, 1884, have also been determined with this instrument. Observations with the great transit instrument have been continued by Wagner, with Wittram as his assistant. The observations (2,348 in number) have chiefly been of the Pulkowa *Hauptsterne.* With the vertical circle Nyrén has zealously pursued his work of determining the declinations of the *Hauptsterne.* Of the 895 observations made during the year, no fewer than 832 were made in both positions of the instrument. In addition to these, 103 observations of the sun were obtained. Romberg, observing with the meridian circle, has obtained 1,236 observations in both elements of different stars taken from, (1), the Åbo Catalogue; (2), the Pulkowa Catalogue of Double Stars; (3), stars used for comet observations; (4), stars used for determining the scale of the heliometer. With the 4-inch Repsold heliometer Backlund has obtained thirty-two measures of distances and thirty measures of position-angles of Jupiter's satellites. Lindemann has investigated the variation of light of V Cygni with the Zöllner photometer (*Observatory*, No. 104, p. 435), and also has observed some other stars, the variability of which has been suspected. Hasselberg's spectroscopic researches have been limited to the chemical elements, nitrogen and hydrogen, which, however, are not yet finished. Photographs of the sun have been regularly taken throughout the year, for which work gelatine plates have been found specially conveneint. During the year 220 photographs have been obtained on 173 days. Referring to the work carried on at the Marine Observatory at Nicolajew, M. Struve remarks that the director has found at Batum an extraordinary deviation of the plumb-line, amounting to 49″·6 in longitude=37″·1 of a great circle in the direction of the prime vertical. In latitude the deviation is 16″. That no volume of Pulkowa observations has been published during the year is owing chiefly to the long illness and multitudinous occupations of the director. The following volumes, however, are in active preparation: Volume VIII, which contains the star catalogue compiled from the meridian observations, 1839 to 1869; volume X, containing the continuation of O. Struve's measures of double stars; volume XII, containing the fundamental determinations of R. A. for 1865.0; and volumes XIII and XIV, containing the fundamental determinations of declination for the same epoch. The work of the geographical and geodetical bureau, under Döllen's superintendence, has also been carried on as usual during the year." (*Observatory*.)

Radcliffe Observatory, Oxford.—With the transit circle 3,500 observations of transits have been made, and 3,440 circle observations. The volume for 1882 has been printed; that for 1883 is nearly ready for press; the observations for 1884 are completely reduced; those for 1885 are nearly reduced to the end of the year.

Rome.—A new observatory is being built under the direction of Father Ferrari, S. J., formerly assistant, and successor of Father Secchi, in the observatory of the Roman College. The observatory is now in possession of a 4-inch equatorial by Merz, and is to have a 10-inch by the same maker. (*Sid. Mess.*, 4 : 313.)

Rosse (*Earl of*), Birr Castle, Parsonstown.—Attention has been given to photometry and the measurement of lunar heat. The driving-clock of the 6-foot reflector is now run by water power.

San José, Cal.—The recently completed observatory for the University of the Pacific, at San José, has a 6-inch Clark equatorial, and a Fauth transit instrument. The dome is 12 feet in diameter inside, covered with galvanized iron, and requires 15 pounds to turn it. The building and instruments are the gift of Capt. Charles Goodall, of San Francisco, and Daniel Jacks, of Monterey. The observatory is under the charge of Prof. J. C. George.

Smith Observatory.—We are very glad to learn that the reported closing of the Smith Observatory of Beloit College on account of lack of funds is incorrect. Mr. Tatlock has been succeeded as director by Mr. Charles A. Bacon. New arrangements have been made for both meteorological and astronomical observations, and special attention will be given to solar and spectroscopic work.

Stonyhurst College Observatory.—Magnetic and meteorological observations have been made in 1884, as during the past fifteen years. On 257 days drawings of the sun were made; the entire chromosphere was measured on 88 days, and spectra of spots were obtained on 36 days. "The glow encircling the sun during the day has never been entirely absent, though it varied in intensity from time to time." . . .

*Strassburg.**—Dr. W. Schur has published his report of the work done at the observatory during the last year. The instruments in use at Strassburg are, (1) the meridian circle; (2) the altazimuth; (3) the great 18-inch refractor; (4) heliometer, and (5) the 6-inch refractor. It would appear, however, that to work these numerous and excellent instruments Dr. Schur has only two assistants. The meridian circle has been chiefly employed in observing stars for the southern zones of the *Astronomische Gesellschaft*, as well as in determining positions of the sun, moon, and large planets and miscellaneous stars, comet-stars, &c. Determinations have also been made of the errors of division of the circle and of the form of the pivots. With the altazimuth, to which Herr Schur appears to have devoted a considerable amount of time and attention, observations of the moon have been commenced. The great refractor has been used for observing comets, and a re-examination of the micrometer-screw shows the necessity of a correction to the results which have been already published. With the heliometer a number of measures of the sun's diameter have been made; whilst the 6-inch refractor has been employed in making a series of measures for the determination of the parallax of ψ^5 Aurigæ. The amount of work performed by Dr. Schur and his assistants is very creditable to them; but at the same time we are constrained to remark that it is a misfortune that an observatory which is so well provided with instruments should not have a larger observing staff, in order that the various instruments might be worked adequately and to the best advantage. (*Observatory*, October, 1885.)

Taschkent.—The main object of the observatory is to co-operate in the surveys and explorations of Turkestan. Four latitudes and longitudes were determined in 1884. Comets, asteroids, and solar-spots have been observed also.

Temple Observatory, Rugby.—The spectroscopic measurement of the motions of stars in the line of sight has been continued, and a new instrument with prisms of bisulphide of carbon—intended for this work—is nearly completed. Double stars measures have been made as in former years, and a catalogue of 900 sets of measures has been published in the Memoirs of the Royal Astronomical Society.

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* *Astron. Nachr., No.* 2675.

United States Naval Observatory.—The report of the Superintendent bears the date of October 5, 1885. Rear-Admiral S. R. Franklin, U. S. Navy, was detached March 31 and ordered to the command of the European squadron. From that date to the 1st of June Commander A. D. Brown acted as Superintendent, when he was relieved by Commodore George E. Belknap.

The 26-inch equatorial, in charge of Professor Hall, has been employed on satellites and double stars. The dome, 43 feet in diameter, is now revolved with great ease by means of a 4 horse-power gas engine. The observations of the satellite of Neptune and those of the two outer satellites of Uranus have been discussed and the results published. The observations of Iapetus have been published since the report closed.

The transit circle has been employed in the same class of work as in the preceding years. Since the last report 5,520 observations have been made. Of these, 90 were of the sun, 70 of the moon, 156 of the major planets, and 64 of the minor planets.

The 9·6-inch equatorial: Professor Frisby was placed in charge April 2, 1885. The work of the instrument has been confined to: (1) Observations of comets, six of which have been systematically observed during the year. These observations have all been reduced to date, and published in various astronomical journals in this country and Europe. (2) Observations of asteroids, principally of such as could not be observed with the transit circle on account of their faintness or their position; thirty-five regular observations of asteroids were made, and twenty-one approximate positions of other asteroids obtained, so that they could readily be observed with the transit circle. (3) Occultations of stars by the moon, whenever practicable. (4) Doubtful observations of stars and asteroids made with other instruments were looked up and decided, this being probably one of the most important uses of the equatorial. A few observations have been made of the variable star in the nebula of Andromeda, which show that the star is decreasing in brightness. Assistant Astronomer Winlock has made several observations of comets, with drawings of their physical peculiarities and changes of appearance.

The prime vertical instrument: The work of reducing the observations made in 1883–'84 by Lieut. C. G. Bowman and Ensign H. Taylor, U. S. Navy, for the determination of the constant of aberration, has been pursued. In July of last year a communication was received from the president of the International Geodetic Conference, asking the co-operation of this Observatory with the Royal Observatory at Lisbon in the determination of the problem of the change of latitudes, the observations to be taken with the prime vertical instruments of the two observatories. Communication was opened and correspondence is still in progress with the director of the observatory at Lisbon, and preparations have been made to undertake the work here very soon after it is known that it will be begun at Lisbon.

Meridian transit instrument: The work has consisted principally of daily observations and reductions for clock corrections in connection with the time service.

Time service: During the past year the demands upon the time service have greatly increased. In Washington, the number of clocks of the Gardner system in the various public offices has increased from 20 to 84. The total number of time-balls now dropped by the Observatory signal is eight, at the following points: Philadelphia, Baltimore, New Orleans, at branch hydrographic offices; New York, Western Union building; Navy Department, Washington; navy-yard Washington; Hampton Roads; Savannah. A ninth will soon be added at the torpedo station in Newport.

The branch observatory at Mare Island, which is fitted with a duplicate of the transmitting apparatus of this Observatory, has been connected with the mainland by a cable, and time signals are transmitted daily along the Pacific coast. A time-ball has been erected on the island for the benefit of the Vallejo shipping, and is dropped daily at noon of the one hundred and twentieth meridian. The Hydrographic Office time-ball at San Francisco is also dropped at the same instant by signal from the Mare Island Observatory.

Photography: In the programme of work proposed for the current year it was stated that the work of taking sun photographs daily would be inaugurated as soon as practicable. The work of the Transit of Venus Commission has up to this time prevented any regular system being adopted.

During the year the names of 1,408 visitors have been recorded, and 1,137 permits were issued for night visitors, for whose accommodation the small equatorial is set apart.

The records kept by the several observers and watchmen show that only about one night in eight is good for observing, while an exceptionally good night for astronomical work cannot be reckoned upon much oftener than once a month.

The Commodore renews the recommendations of his predecessors that the Observatory be removed* to the new site purchased in 1880, and that a board of visitors be appointed to visit the institution annually.

A special report of Professor Harkness is added, giving the progress of the work of the Transit of Venus Commission.

Upsala.—The unpublished observations of nebulæ and clusters up to 1880 are now prepared for the press. With the Zoellner photometer it is proposed to determine the magnitudes of the comparison stars used by Argelander, Schoenfeld, and Oudemanns for variables.

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*A committee of the National Academy of Science has, at the request of the Secretary of the Navy, given careful consideration to this question. Their report may be found in *Senate Executive Document No.* 67, *49th Congress*, *1st session*.

Warner Observatory.—The 16-inch refractor has been used for the past three years mainly in the search for new nebulæ. A catalogue of some 200 faint nebulæ has been published.

Washburn Observatory.—"The third volume of the 'Publications of the Washburn Observatory,' lately issued, gives the results of the work of 1884. About 1,800 observations were made with the Repsold meridian-circle upon the Gesellschaft southern fundamental stars and the Leyden Cape of Good Hope refraction-stars. The instrumental constants are given for each observing day, and an investigation of the zenith-distance micrometer-screw and of the horizontal flexure of the instrument. In the cold winter weather of Wisconsin the micrometer-springs turned out too weak to pull the slides, and had to be replaced with stiffer ones. The probable error of a single declination is now reduced to 0″·4, a great improvement over that noted in vol. II.; and a correction of +0″·30 ± 0″·026 to the constant of the 'Pulkowa refractions' seems to be called for by the observations of 1884 to suit the atmosphere over Madison. Professor Holden expresses his continued satisfaction with the Repsold meridian-circle, and appears to be making a very thorough study of it; and in this his example might well be followed with profit by some of our older established observatories. Two determinations of the latitude by Mr. G. C. Comstock are given—one from Professor Holden's and his own observations with the zenith-telescope, the other from his own with the prime-vertical transit, using both reflected and direct observations; the declinations in both cases being those of Auwers' system. They come out respectively +43° 4′ 36″·97 ± 0″·07 and +43° 4′ 36″·99 ± 0″·06, remarkably accordant results. The fifth part of the volume is a 'Catalogue of 1,001 southern stars for 1850·0 from observations by Signor P. Tacchini, at Palermo, in the years 1867, 1868, 1869,' by Rev. Father Hagen, S. J., and Edward S. Holden. The original observations had never been reduced to mean place, but being good ones and in a part of the sky where needed, we have here the anomaly of European work reduced and published in this country; and Father Hagen and Professor Holden are to be highly commended for making it available, while its comparison with Oeltzen's Argelander (south) and the Washington zones served to detect many errors in these catalogues. The sixth part gives the observations of 437 southern stars made with the Washington transit-circle, and also the position of the same stars (whenever occurring) from the catalogues of Yarnall, Gould's zones, and Stone, all the positions being reduced to 1850.0 by Father Hagen. This is the first opportunity for easy comparison on a large scale between these four systems of southern declinations, and the comparison develops the following important differences of north polar-distance:—

Washington—Yarnall = +1″·12 (from 220 stars).
Washington—Gould (Z. C.) = +1″·96 (from 215 stars).
Washington—Stone = +1″·00 (from 238 stars).

. . . "The volume closes with a count of the *Durchmusterung* stars between —2° and +13°, a determination of the constants of some of the other instruments, meteorological observations for 1884, a summary of the same as taken at Madison continuously from 1853 to 1884, and is throughout a highly creditable publication." . . . (*Science*, November 20, 1885.)

Willets Point Observatory.—The astronomical observations made during 1885 were of the same nature as those described at some length for the preceding year in the "Account of the Progress in Astronomy in 1884." The observatory is established for training engineer officers in the applications of practical astronomy to geodesy. The course of instruction, as well as the arrangement of the observatory building and its equipment (described and illustrated with a plan of the observatory in *General order* No. 3, series of 1881, and *Printed order* No. 3, series of 1882), may well be taken as a model in this branch of astronomy. A large number of latitude observations made by different observers from 1880 to 1884, and apparently showing a steady decrease in the latitude of the post, has been submitted to a critical discussion by Miss Alice Lamb, of the Washburn Observatory. By selecting the best determined stars, and by rejecting the observations with one of the instruments, and the work of some observers, whose probable errors are about twice as large as the probable errors of those whose work is retained, she concludes that there is strong reason to attribute the systematic change to errors of observation rather than to a real diminution of the latitude.

Yale College Observatory.—The following is a brief statement of the work accomplished or in progress under the direction of Dr. W. L. Elkins, who has charge of the heliometer, the only instrument of that class, we believe, in operation in this country.

The principal object of research has been the triangulation of the Pleiades, to which work the instrument was devoted from September, 1884, to March, 1885. It was originally intended to confine the investigation to the stars measured at Königsberg; the scheme has been extended, however, to include all the stars in the Bonn Durchmusterung, within certain limits, down to the magnitude 9·2, making sixty-nine stars in all. The reductions are in a forward state.

Other observations are reported:

Measures of the Moon from neighboring stars, diameters of the Moon, diameters of Venus, and the outer ring of Saturn, and a series of observations of Titan referred to its primary, which is being continued by Mr. A. Hall, jr.

There have been various additions made to the working appliances of the instrument. The oil-lamps illuminating the scales and circles have been replaced by half-candle incandescent lamps. The most important addition is, however, the registering micrometer, which Messrs. Repsold have made for reading the scales. The principle consists in impressing on a Morse fillet the figures and divisions of the micrometer head along with those of a fixed index.

The instrument is now being devoted to systematic investigations in stellar parallax, and work is progressing, which will furnish, it is hoped, reliable values of the parallaxes of the ten stars of the 1st magnitude in the Northern Hemisphere referred to neighboring stars of about the 8th magnitude.

Zurich.—The sun-spots are assiduously observed here. The maximum occurred in December, 1883, to January, 1884.

ASTRONOMICAL INSTRUMENTS.

Wire-gauze screens as photometers.—"Of late years the use of wire-gauze screens, one or more in number, over objectives has come into use for several purposes. Over one of the halves of a heliometer-objective they are used to reduce the image of a bright star to approximate equality with that of a fainter star from the other half, an essential condition for the most accurate superposition of the two images. With a meridian circle they are used to reduce the brighter stars to an approximate equality with the faintest that can be observed with satisfactory precision, or to investigate the difference of personal equation for different magnitudes by taking different tallies of transit-wires, with screen off and on, at the same transit. In the latter case Professor Holden points out the necessity (*Astron. Nachr.* 2690) of changing the illumination of the field with the change of screen, so that each magnitude may show against its customary degree of color or brilliancy of background. Such screens may also be used for photometric purposes when once their coefficients of transmission have been determined. Those having occasion to use them in this way will do well to consult a paper by Professor Langley (*Amer. Journ. Sc.*, xxx, 210) on this subject. In this it is shown that the effective transmission coefficients are decidedly different according as the luminous image is an extended surface or practically a point like a star. In the latter case there is a central image surrounded by a system of diffraction images, into which a large part of the light goes; so much so, that Professor Langley found that a screen (of which one and two thicknesses transmitted ·47 and ·21 respectively of the full light upon a surface) gave only ·18 and ·02 for one and two thicknesses, respectively, when measured by the brilliancy of the central image of a small pin-hole as a source of light." (*Science.*)

The defining power of telescopes.—Quite a warm discussion has been going on in the columns of the *Observatory* and *Sidereal Messenger* on the relative merits of small and large telescopes for the study of planetary detail. The controversy seems to have arisen from a statement by Mr. Denning to the effect that "apertures of from 6 to 8 inches seem able to compete with the most powerful instruments ever constructed." The true state of the case appears to be given in a note by Professor

Young (*Observatory*, VIII: 173, May, 1885): "On the whole, I find also true what Mr. Clark told me would be the case on first mounting our 23-inch instrument, *that I can almost always see with the 23-inch everything I can see with the 9½-inch, under the same atmospheric conditions, and see it better;*—if the seeing is bad, only a little better,—if good, immensely better. The only exceptions are in the case of objects which require a very low power, lower than any that can be obtained with the eye-pieces of the large telescope."

The great Pulkowa refractor.—"M. Struve was chiefly occupied during the year with work incidental to the installation of the great 30-inch refractor. It was anticipated that by September, 1884, things would be in such a state that it would be possible to begin to observe with this gigantic instrument; but, owing to various delays, chiefly connected with the construction of the dome, it was not until the end of September that the Repsolds could be invited to come to Pulkowa to superintend the work of erecting the telescope; this was accomplished very successfully by them in about three weeks. And M. Struve expresses himself as greatly pleased with the ease with which the telescope can be set, with the equality of the illumination on all its parts from a single lamp, with the accuracy with which the driving-clock performs, and with the facilities for altering the telescope into a powerful spectroscope; so that this great instrument may be regarded as the successful outcome of the highest skill of modern art in this department. Further work on the dome was interrupted by the approach of winter. - - - At present the dome is moved by hand; it is hoped, however, that this may eventually be done by electricity, and that a motive power will thus be obtained sufficient to overcome the hindrances to the rotation of the dome arising from snow and frost. From investigations made by H. Struve it appears that the position of the polar axis is correct to a fraction of a minute, that the change in focal length of the instrument during the winter is but trifling, and that, notwithstanding the great weight of the object-glass and of the eye-end, the flexure of the telescope is so small as to be practically insensible. M. Struve proposes to use the great refractor for observing such double-stars as are beyond the reach of the 15-inch equatorial, and to undertake observations of certain interesting nebulæ, as well as spectroscopic researches on stars in cases where the great optical power of the instrument will make the observations of special value." (*Observatory.*)

"Science" (VI: 306) publishes a letter from Dr. Otto Struve to Alvan Clark & Sons, from which we make the following extract: "I am asked by the Government to inform you that, in acknowledgment of the excellent performances of the great object-glass furnished for Pulkowa by your firm, His Majesty the Emperor has been graciously pleased to confer upon you the golden honorary medal of the empire. The value of this gift is enhanced by the circumstance that this medal is given very rarely and only for quite extraordinary merits. You and Repsold are the first who will receive it from the present Emperor, Alexander III." - - -

"You will be pleased to hear that with the 30-inch refractor in good nights all the most difficult double-stars discovered by Burnham with the Washington refractor can be easily measured."

Illumination by means of the electric light.—In regard to the application of electricity to illuminating the microscopes and field of view of a large fixed instrument, Dr. Gill, of the Cape Observatory, says: "Electric illumination by small incandescent lamps has been applied with complete success to the microscopes and field of the great theodolite with which the azimuth observations are made. The electricity is supplied to the lamps from a storage battery, which is charged during daytime two or three times a week by a small Grove battery. The success of the experiment has been complete. The whole arrangement is so simple, clean, and convenient, and the advantages to accuracy of observation by perfect uniformity of light, freedom from flicker, glare, and heat can only be fully appreciated after trial."

*Method of supporting a mercury trough for reflection observations.**—"The observation of the nadir has hitherto been almost impossible at the Paris Observatory, owing to the disturbance of the mercury caused by the traffic in the neighboring streets. Lately, however, M. Gautier has devised a very simple arrangement by which this is obviated. The new apparatus consists of two cylindrical basins placed one above the other, the lower one, which contains the supply of mercury, having a slightly larger diameter than the upper. The bottom of the lower basin is pierced at its center to admit a screw which projects in a vertical direction into the inside and is fixed in that position. A cylinder, fixed as an axis to the bottom of the smaller basin, is tapped to fit the projecting screw, and thus, by turning this basin round its axis, it can be raised or lowered in the larger vessel so as to obtain a supply of mercury in it (by means of an opening provided for the purpose) sufficient for observation, whilst the oscillations of the ground, Admiral Mouchez states in the paper before us, are completely counteracted by the 'demi-flottage' of the second basin." (*Observatory.*)

Hough's printing chronograph.—At the Ann Arbor meeting of the American Association, Professor Hough read a paper on the printing chronograph that he has invented. He has given a description of the instrument in his report as director of the Dearborn Observatory for 1885. The instrument is designed to print on a fillet of paper, minutes, seconds, and hundredths of seconds, indicated by the clock which controls it, at any instant that an observing key is closed by the observer's finger. The impression is made from the surface of three continuously running type wheels, the swiftest of which revolves once per second. The recent improvements consist in engraved type on the face of the wheels in place of the rubber ones used at first, and of the substitution of a direct blow by an electro-magnet upon the type wheel fillet, thus making the apparatus much more light and compact than the old form. The mean of the seconds and hundredths may be taken directly on the fillet without transference to books. Professor Hough states that the instrument has proved perfectly reliable.

**Bull. Astron.*, 2:549; also (abstr.), *Eng. Mechan.*, 42:488.

Flexure of transit instruments.—At the same meeting of the American Association a paper was presented by Professor Harkness on the general subject of the flexure of transit instruments. Professor Harkness's thorough investigation of this subject has just been published as Appendix III to the "Washington Observations" for 1882.

Optical works of Feil & Mantois.—We learn from *L'Astronomie* that M. Charles Feil has, after some years' absence, returned to the active management of his celebrated manufactory of optical glass in Paris, the new firm being "Feil père et Mantois." M. Feil is grandson of M. Guinaud, the founder of the house in 1827. The new firm succeeded in obtaining a crown disk of the requisite size for the Lick 36-inch glass, having already furnished to MM. Henry the disk for the 30-inch objective for the Nice Observatory.

Micrometer.—Mr. Chandler contributes to volume 11 of the Memoirs of the American Academy a valuable paper on the "Square-bar micrometer."

MISCELLANEOUS.

Astronomical prizes.—The Lalande prize of the Paris *Acadèmie des Sciences* has been decreed to M. Thollon for his great map of the solar spectrum. This map, which has so far demanded four years of uninterrupted work, extends from *A* to *b*, and contains 3,200 lines, 900 of which M. Thollon has been able to identify as of telluric origin. The Damoiseau prize is reserved, no memoir having been offered for it. The subject proposed is the same as in former years—a revision of the theory of the satellites of Jupiter, a discussion of observations with special reference to the direct determination of the velocity of light, and lastly, the construction of particular tables for each satellite. The Valz prize has been awarded to Dr. Spörer for his researches on sun spots, his discovery of the striking relationship between the distribution of the spots in latitude and the epochs of their maxima and minima receiving special notice. (*Nature.*)

The award of the Draper medal, made for the first time, was most appropriately bestowed on Prof. S. P. Langley, of Allegheny, for his researches and discoveries in solar radiation.

The Warner prizes awarded in 1885 were two, of $200 each, to Mr. E. E. Barnard, for the discovery of Comet 1885 II, and Comet *e* 1885, and two, of $200 each, to Mr. W. R. Brooks, for the discovery of Comets 1885 III, and 1885 V. Mr. Warner has just given four prizes, aggregating $450, for essays on the remarkable "red sunsets" which have been prevalent during the past few years, and medals have been awarded to a number of other competitors. The total amount that has been awarded by Mr. Warner for astronomical prizes since 1880, including a small amount for the expenses of judges, is $3,750. The Warner comet prize is continued from March 1, 1886, to March 1, 1887. It is reduced to $100, but is open to the world.

On the apparent increase of size of the sun, moon, and constellations when seen at the horizon. (*From the Bulletin de l'Académie royale de Belgique.*)—"The apparent increase of the diameter of the sun or moon is ordinarily attributed to the elliptical form of the celestial sphere. According to the author this explanation was given as early as the eleventh century in the Optics of Alhazen. But by experiments, comparing in a dark room the distances of two electric sparks at the height of the eye and near the ceiling, M. Stroobant was led to the conclusion that any object seen in the zenith appears only eight-tenths as large as when seen at the horizon. But there is another factor which should be taken into account, that is, the variable brightness of the star. The author thinks that a special study should be made of these very interesting physiological phenomena." (*Bull. Astron.*, April, 1885.)

Sammlung populaerer Astronomische Mittheilungen.—The eminent director of the Berlin Observatory Herr Foerster, has collected in this volume a series of scientific notices of a popular character, which have appeared since 1880 in successive volumes of the official calendar (*Normal-Kalender*). It contains a clear exposition of the state of our knowledge of the fixed stars, their distances, and their distribution in space; an article upon the limits of our perceptions of celestial objects; some interesting remarks upon the auroras, the zodiacal light, and the recent comets. In reviewing these notices, we are struck with the multiplicity and the importance of the problems offered us by modern astronomy, and are tempted to ask, with Herr Foerster, if the number of those at work at these problems is not becoming too small for the task.

An index to astronomical literature.—The need of some systematic index to the current literature of astronomy (to say nothing of the desired extension of the Royal Society's catalogue, or the completion of Houzeau's work) is more strongly felt year by year; and the difficulty is aggravated by the poor and insufficient indexes furnished with most astronomical publications. General periodical literature is provided for by Poole's Index, which is kept up to date by the Co-operative Index to Periodicals; and a committee of the American Association on indexing chemical literature reports each year favorable progress. It seems highly desirable that some similar co-operation should be organized among astronomers.

ASTRONOMICAL BIBLIOGRAPHY, 1885.

Following is a list of the principal books of the year, compiled largely from the excellent *Naturæ Novitates* of R. Friedländer & Sohn, Berlin. Reprints from transactions and periodicals are frequently included. The prices quoted are in German marks (4 marks equal to $1, very nearly), and are those given by Friedländer.

Acta Mathematica.—Zeitschrift, hersg. v. G. Mittag-Leffler. Bd. 5. Stockholm, 1885. 4to. 12

—— Same. Bd. 6. 12

Addresses at the complimentary dinner to Dr. Benjamin Apthorp Gould. May 6, 1885. Lynn, 1885. 40 p. 8vo.

Airy (G. B.).—Gravitation; an elementary explanation of the principal perturbations in the solar system. 2 ed. London, 1885. 186 p. 8vo. 7.80

Albrecht (Th.).—Bestimmungen der Länge des Secundenpendels in Leipzig, Dresden u. dem Abrahamschacht bei Freiberg, in den Jahren 1869–71 ausgeführt. Berlin, 1885. 4to. 5

Almanach de l'Observatoire royal de Bruxelles. Année 52, 1885. Bruxelles, 1885. 374 p. 16mo. 1.50

American Academy.—Memoirs of the American Academy of Arts and Sciences. Centennial volume. (Vol. XI, part 2, No. 1.) Cambridge, 1885. 4to.

—— Proceedings of the American Academy of Arts and Sciences. New series, vol. 12. (Whole series, vol. 20, from May, 1884, to May, 1885.) Boston, 1885. 8vo.

American Association.—Proceedings of the American Association for the Advancement of Science. Philadelphia, 1884. Vol. 33. Salem, 1885. 95+736 p. 8vo.

American Astronomical Society.—Papers. No. 1. Brooklyn, 1885. 32 p. 8vo.

American Ephemeris and Nautical Almanac for the year 1888. 1st ed. Washington, 1885. 519 p.+ 4to.

American Ephemeris.—Astronomical papers, prepared for the use of the American Ephemeris and Nautical Almanac. Vol. II, parts 3, 4. Washington, 1885. p. 107–258, with 8 plates. 4to. 7.50

Cont.: Newcomb and Michelson, Measures of the velocity of light, made 1880–'82.

—— Astronomical papers, prepared for the use of the American Ephemeris and Nautical Almanac. Vol. III, parts 2, 3, 4. Washington, 1884. p. 201–371. 4to. 10

Cont.: Hill, Lunar inequalities due to the ellipticity of the earth. Newcomb, On the motion of Hyperion. Hill, Lunar inequalities due to the action of Jupiter.

American Journal of Mathematics. Vol. I–VI. (Vol. I very rare.)

American Philosophical Society.—Early proceedings, from 1744 to 1838. Compiled by one of the secretaries, with full indexes and phototypic illustrations. Philadelphia, 1885. 875 p. 8vo. 25

Analyst (The), including the proceedings of the "Society of Public Analysts." Ed. by G. W. Wigner and J. Muter. Vol. 10 (12 nos.). London, 1885. Roy. 8vo. 6.50

Annalen (Mathematische). In Verbindung m. C. Neumann begründ. d. R. F. A. Clebsch. Hersg. v. F. Klein u. A. Mayer. Band 25 (4 Hefte). Leipzig, 1885. 8vo. 20

—— Same. Band 26 (4 Hefte). Leipzig, 1886. 8vo. 20

Annales du Bureau des Longitudes. Travaux faits à l'Observatoire astronomique de Montsouris (Section navale) et Mémoires divers. Tome III. Paris, 1885. 6+506 p. 4to. 21

Annales Nouvelles des Mathématiques. Réd. p. Gérono et Brisse. Année 1885. (Série V, tome 4) en 12 nrs. Paris, 1885. 8vo. 15

Annals of mathematics, pure and applied. Edited by O. Stone and W. M. Thornton. University of Virginia. Year 2 (6 nrs.), 1885. 4to. 10

Continuation of the "Analyst," formerly published by J. C. Hendricks.

Annuaire du Bureau des Longitudes pour l'année 1886. Paris [1886?]. 924 p. 4to. Illustr. 1.70

Cont.: Faye, Les 13 Tornados des 29 et 30 Mai, 1879, aux États-Unis.

Anuario del Observatorio Astronomico nacional de Tacubaya para el año de 1885. Mexico, 1884. 12mo. 12

Astronomical Register.—Vol. 23. Year 1885 (12 nrs.). London, 1885, 7+300 p. 8vo. 12.50

L'Astronomie. Revue mensuelle d'Astronomie populaire, de Météorologie et de Physique du Globe, publ. p. C. Flammarion. Année 4, 1885 (12 nrs.). Paris, 1885. 488 p. Imp. 8vo. Illustr. 12

Atti della R. Accademia dei Lincei, 1883–'84. Memorie della Classe di Scienze fisiche, matematiche e naturali. Vol. 17. Roma, 1884. 60+619 p. 4to. 34

Cont.: Dembowski, Misure micrometriche di Stelle Doppie e Multiple, fatte negli anni 1852–'78. Vol. ii.

Bäcklund (O.).—Ueber d. Anwendung einer von P. Tschebyschew vorgeschlagenen Interpolationsmethode. (St. Petersb. Acad.) 1885. 30 p. Roy. 8vo. 1

Bakhuyzen (H. G. van de Sande).—Untersuchungen über die Rotationszeit des Planeten Mars, und über Änderungen seiner Flecks. Ann. d. Sternwart. in Leiden 7. [1885.]

Ball (R. S.).—The story of the heavens. London, 1885. 544 p., 16 pl., 90 woodcuts. 8vo. 3.70

Berlin. Astronomisch-geodätische Arbeiten in den Jahren 1883–'84, hersg. v. kgl. geodät-Institut zu Berlin. Berlin, 1885. 4to. 13.50

Cont.: Bestimmungen der Längendifferenzen Berlin-Swinemünde, Kiel-Swinemünde, Swinemünde-Königsberg, Königsb.-Warschau u. Berlin-Warschau.

Boeddicker (O.).—On the changes of the radiation of heat from the moon, during the total eclipse of 1884, October 4, as measured at the observatory, Birr Castle. Sc. Trans. Roy. Dub. Soc. vol. 3 (2s), p. 321–32. 2 pl. (1885.)

Boletin de la Academia Nacional de Ciencias en Córdoba (República Argentina). Tomo vi, entrega 4. Buenos Ayres, 1884. p. 351–516, 49–64. p. Roy. 8vo. 4

Cont.: Doering, O., Observat. météorol. faites à Cordoba pend. l'a. 1883. Knopf, O., Determinación de la latitud de alg. lugares de la Repúbl. Argentina. Peter, B., Informe s. las Observac. del paso de Venus, pract. p. la Comisión Astron. Alemana en Bahia Blanca.

Bolton (H. C.).—Catalogue of scientific and technical periodicals 1665–1882, in all languages. Washington, 1885. 783 p. Roy. 8vo.

5,100 titles of scientific periodicals.

Bordeaux Observatory.—Annales de l'Observatoire de Bordeaux, publ. p. Rayet. Tome i. Bordeaux, 1885. 4to. 25

Brown (A. D.) and **Winterhalter** (A. G.).—Annular eclipse of the sun, March 15–16, 1885. (Wash. Obsns., 1882, App. ii.) Washington, 1855. 34 p., 1 pl. 4to.

Bulletin Astronomique, dirigé p. Tisserand, G. Bigourdan, O. Callandreau et R. Radau. Année 2, 1885 (en 12 livrais). Paris, 1885. 611 p. 8vo. 16

Bulletin des Sciences Mathématiques et Astronomiques, rédig. p. Darboux, Houel et Tannery. Année 1885 (Série II, tome 9). Paris, 1885. Roy. 8vo. 18

Bulletin hebdomadaire de l'Association Scientifique de France, fondé p. Le Verrier, publ. s. la dir. du président de la Société. Année 1885. (Série II, tomes 10 et 11.) Paris, 1885. 8vo. 17

Bredichin (Th.).—Révision des valeurs numériques de la force répulsive. Moscou, 1885. 36 p. 8vo. 1.50

——— Quelques formules de la théorie des Comètes. Moscou, 1884. 14 p. 8vo. 1

——— Sur les têtes des Comètes. Moscou, 1885. 8 p., 2 fig. 8vo. 0.60

——— Sur la grande Comète de 1811. Moscou, 1885. 12 p., 1 pl. 8vo. 1

——— Sur les oscillations des jets d'émission dans les Comètes. (Moscou, Bull. d. Nat., 1885.) 25 p., 1 pl. 8vo. 1.50

Cape catalogue of 4,810 stars for 1850. [London, 1884.] 17+215 p. Roy. 8vo.

Carrington (R. C.).—Charts of circumpolar stars. Ten charts, published by the Meteorological Office. London, 1885. Fol.

Cellérier (G.).—Concours national de Compensation des Chronomètres pour les Températures. Méthode de Classement, Calcul des Bulletins et Etude numérique de l'erreur secondaire de Compensation. Genève, 1885. Avec 12 pl. Roy. 4to. 16

Chambers (G. F.).—Hints on the construction and equipment of observatories for amateurs (ill.). *Nature*, 33 : 56–60 (1885).

Chandler (S. C.), jr.—On the square bar micrometer. *Mem. Am. Acad.*, 11 : 158–77 (1885).

Chauvenet (W.).—Spherical and practical astronomy (University edition). With an appendix on the method of least squares. 5th ed., revised and corrected. 2 vols. Philadelphia, 1885. 8vo. 34

Chicago Astronomical Society.—Annual report of the board of directors, together with the report of the director of the Dearborn Observatory, 1885. Chicago, 1885. 16 p., 2 pl. 8vo.

Ciel et Terre.—Revue populaire d'Astronomie et de Météorologie. Année 1885. Bruxelles, 1885. 8vo. 8

Clarke (H. W.).—The Sextant, London, 1885. 44 p. 16mo. 2.20

Clerke (Agnes M.).—Popular history of astronomy during the nineteenth century. London, 1885. 480 p. 8vo. 13

Coffin (J. H. C.).—Reports of observations of the total eclipse of the sun, August 7, 1869, made by parties under the general direction of Prof. J. H. C. Coffin, U. S. N., Superintendent of the American Ephemeris and Nautical Almanac. [Washington, 1885.] 2+158 p., 10 pl. 4to.

Comptes rendus hebdomadaires des Séances de l'Académie des Sciences. Année 1885. (Tomes 100 et 101 en 52 nrs.) Paris, 1885. 4to. 29.50

Conference (International) held at Washington [1884] for the purpose of fixing a prime meridian and a uniform day. Protocols of the proceedings. Washington, 1884. 212 p. 8vo.

Conférence internationale tenue à Washington pour l'adoption d'un premier méridien unique et d'une heure universelle. Octobre, 1884. Procés-verbaux des Séances. Washington, 1884. 216 p. 8vo.

Connaissance des temps pour l'an 1887. Paris, 1885. 5+808+127 p. 8vo.

Crawford (Lord).—Determinations of longitude and latitude during the Mauritius Expedition, 1874. Dun Echt, 1885. 12+519 p., 2 pl. Roy. 4to. 25

Dembowski (E.).—Misure micrometriche di Stelle Doppie e Multiple fatte negli Anni 1852–'78. Vol. II. Roma, 1885. 4to. 34

——. Same. Vol. I. 1883. 22

Doberck (W.).—Markree Observatory. (From "The Observatory" 1884.) 8 p. 8vo. 1

——. Observations and researches made at the Hong-Kong Observatory in the year 1884. Hong-Kong, 1885. 218 p. fol. 10

Doolittle (C. L.).—A treatise on practical astronomy, as applied to geodesy and navigation. New York, 1885. 10+642 p. 8vo.

Dublin Society (Royal).—Scientific transactions. Vol. III, p. 1–6. Dublin, 1884–'85. 300 p., 5 pl. 4to. 16

Dun Echt Observatory, publications. Vol. III. Mauritius Expedition, 1874. Division II. Determinations of longitude and latitude. Dun Echt, 1885. 12+519 p., 2 pl. 4to. 25

Dunér (N. C.).—Sur les étoiles à spectres de la troisième classe. Stockholm, 1885. 137 p., 1 pl. 4to.

Dunsink Observatory.—Astronomical observations and researches made at Dunsink, the observatory of Trinity College, Dublin. Published by R. S. Ball. Part 5. Dublin, 1884. 244 p., 2 pl. 4to. 12

Dupuis (H.).—Tables de Logarithmes à cinq Décimales, d'après J. de Lalande. Paris, 1885. 4+230 p. 12mo. 2

Dupuis (J.).—Tables de Logarithmes à sept décimales d'après Bremiker, Callet, Véga, &c. Edit. stéréotype. 10. tirage. Paris, 1885. 12+580 p. 8vo. 7.50

Eckhardt (C. L. P.).—Neue Sternkarte. Neu bearb. v. W. Soldan. 6. Aufl. Giessen, 1885. Fol. lithogr. in Carton. 4

Espin (T. H. E.).—Elementary star atlas; a series of 12 simple star maps with descriptive letter-press. Preface by J. A. Westwood Oliver. London, 1885. Roy. 8vo. 1.70

Europäische Gradmessung.—Astronomisch-geodätische Arbeiten für die europäische Gradmessung im Königr. Sachsen. Abtheilg. iii. Die astronomischen Arbeiten. Ausgeführt unter Leitung v. C. Bruhns, bearbeit. v. Th. Albrecht. Heft 2. Berlin, 1885. 4to. 12

——. Same. Heft 1. 1883. 10

Faye (H.).—Sur l'Origine du Monde. Théories cosmogéniques des Anciens et des Modernes. Paris, 1884. 260 p., 22 Fig. 8vo. 4.50

Fellowes (F.).—Astronomy for beginners. New York, 1885. 135 p. 12mo. illustrated. 3

Fischer (A. L.).—Die Sonnenflecken und das Wetter. Heft 4. Beobachtungen seit 1 Juli 1883. Erfurt, 1885. 8vo. 1.60

——. Same. Heft 1–3. 5

Flammarion (C.).—Contemplations scientifiques. (Série i.) 4 édit. Paris, 1885. 12+456 p. 16mo. 3.50

—— Les Merveilles célestes. Lectures du Soir. 8 édit. Paris, 1885. 6+359 p. avec 87 vign. et 2 cartes. 12mo. 2.20

Forster (A.).—Studien zur Entwicklungsgeschichte des Sonnensystems. Stuttgart, 1885. 8+60 p., 5 Fig. 8vo. 2.60

Förster (W.).—Populäre Mittheilungen zum astronomischen Theile des königl. preussischen Normalkalenders für 1886. Berlin, 1885. 8vo. 1

Förster and **Lehmann** (P.).—Die veränderlichen Tafeln des astronomischen und chronologischen Theiles des königl. preussischen Normalkalenders für 1886. Berlin, 1885. 8vo. 5

Fortschritte (Die) der Astronomie 1885. (Nr. 11.) Red. H. J. Klein. Köln, 1885. 8vo. 1.80

Fritz (H.).—Die Sonne. Zürich, 1885. 32 p., 1 Tfl. 4to.

Galle (J. G.).—Uebersicht über die Bahn-Elemente der seit dem Jahre 1860 erschienenen Cometen, sowie über neu berechnete oder verbesserte Bahnen von Cometen der früheren Zeit. *Astron. Nachr.*, 112: 1–26; 113: 55 (1885).

Gauss (F. G.).—Fünfstellige vollständige logarithmische und trigonometrische Tafeln. 23. Aufl. Halle, 1885. 8vo. 2

Geelmuyden (H.).—Undersögelse af Parallaxen af en Stjerne i den store Björn og nogle Bemærkninger om det dertil anvendte Mikrometer. Christiania, 1885. 19 p., 1 Fig. 8vo. 0.70

Giornale di Scienze naturali ed economiche, publ. d. Società di Scienze naturali ed economiche di Palermo. Vol. 16, 1883–'84. Palermo, 1884. 245+203 p 4to. 16

Cont.: Di Stefano, S. altri fossili d. Titanio inferiore di Sicilia. Cardani, S. alcune figure ottenute p. elettrolisi. Ricco, Riassunto d. osservazioni astrofisiche solari eseguite nell' Osservatorio di Palermo nel 1882. Zona, Coordinate geografiche e costruzione di una grande meridiana a tempo vero e medio in Castiglione Etneo. . . .

Gore (J. E.).—A catalogue of known variable stars, with notes and observations. Dublin, 1884. 8vo. 2

—— A catalogue of suspected variable stars, with notes and observations. Dublin (Proc. R. Ir. Ac.), 1885. 8vo. 8

Gould (B. A.).—Resultados del Observatorio Nacional Argentino en Córdoba. Vol. 3. Observaciones de Zonas d'año 1873. Buenos Aires, 1884. 510 p. 4to. 25

——— Resultados del Observatorio Nacional Argentino en Córdoba. Vol. 7, 8; Catalogo de las Zonas Estelares. Cordoba, 1884. 4to.

Grubb (H.).—On a new form of equatorial telescope. Dublin (Roy. Soc.), 1884. 4to. illustr. 2.50

Gruey.—Leçons d'Astronomie. Besançon, 1885. Volume lithographié de 368 p, 4to. 16

Gyldén (H.).—Grunddragen af en enkel method att lösa atskilliga problem i den analytiska mekaniken. (Stockholm) 1884. 24 p. 8vo. 1.50

Hall (A.).—The orbits of Oberon and Titania. (Wash. Obsns., 1881, App. I.) Washington, 1885. 33 p. 4to.

——— Orbit of the satellite of Neptune. (Wash. Obsns., 1881, App. II.) Washington, 1885. 27 p. 4to.

——— The orbit of Iapetus. (Wash. Obsns., 1882, App. I.) Washington, 1885. 82 p. 4to.

Harvard College Observatory.—Annals of the Astronomical Observatory of Harvard College. Vol. XIV, in 2 parts. Cambridge, 1885. 512 p. Roy. 4to.

——— Catalogue of 1,213 stars. Cambridge, 1884. 7 + 93 p 4to.

——— Report (40th annual) of the director, by Edward C. Pickering. December 3, 1885. Cambridge, 1886. 13 p. 8vo.

Henrici (J.).—Die Erforschung der Schwere durch Galilei, Huygens, Newton als Grundlage der rationellen Kinematik u. Dynamik historisch-didaktisch dargestellt. Leipzig, 1885. 40 p., 6 Fig. 4to. 1.80

von Hepperger (J.).—Ueber die Verschiebung des Vereinigungspunktes der Strahlen beim Durchgange eines Strahlenbüschels monochromatischen Lichtes durch ein Prisma mit gerader Durchsicht. Wien, 1885. 27 p., 2 Holzschn. 8vo. 0.50

——— Ueber Krümmungsversuche und Dispersion von Prismen. Wien, 1885. 40 p., 8 Holzschn. 8vo. 0.80

Herz (N.).—Entwicklung der störenden Kräfte nach Vielfachen der mittleren Anomalien in independenter Form. Wien, 1885. 46 p. 8vo. 0.80

——— Siebenstellige Logarithmen der trigonometrischen Funktionen für jede Zeitsecunde des Quadranten. Zum astronomischen Gebrauch. Leipzig, 1885. 8vo. 4

Hildesheimer (L.).—Alphabetisches Verzeichniss der sich in J. Schmidt's Mondcharte befindlichen Objecte. Odessa, 1885. 10 p. 8vo.

Hill (G. W.).—Determination of the inequalities of the moon's motion, which are produced by the figure of the earth; a supplement to Delaunay's Lunar Theory. *Astron. Papers Am. Ephem.*, 3: 205–344 (part 2, 1884). 8

——— On certain lunar inequalities due to the action of Jupiter and discovered by Mr. E. Neison. *Astron. Papers Am. Ephem.*, 3: 377–393 (part 4, 1885).

Holden (E. S.).—An account of the progress of astronomy in the year 1884. (From the Smithsonian Report for 1884.) Washington, 1885. 55 p. 8vo.

——— Publications of the Washburn Observatory. Vol. III. Madison, 1885. 139 p. 8vo.

——— Report of Eclipse expedition to Caroline Island, May, 1883. *Mem. Nat. Acad.* 2: 16–146 (1884).

Houzeau (J. C.).—Passage de Vénus du 6 Déc. 1882. Partie I: Exposé des résultats des observations faites aux Stations Belges, à l'aide d'Héliomètres à foyers inégaux. Bruxelles, 1884. 35 p. 4to. 4

Huggins (W.).—On the corona of the sun. (Bakerian lecture.) *Proceedings Royal Society*, 39: 108–135. (1885.)

Huyghens (Chr.).—Traité de la lumière avec un discours de la cause de la pesanteur. (New edition of this extremely rare and still very valuable book by W. Burckhardt.) 1885.

Index to periodicals (The Co-operative) for 1885. Edited by W. I. Fletcher. Vol. I. New York, 1886. 6 + 111 p. 8vo.

Irish Academy (Royal). Proceedings. Vol. IV, Nr. 1, 2. Dublin, 1884. 278+22 p. 8vo.

——. Transactions. Vol. 28 (science), part 14–17. Dublin, 1884. Roy. 4to. 6.50

Israel-Holtzwart (K.).—Elemente der theoretischen Astronomie. Abtheilung 1: Theorie der elliptischen Bewegung und der Bahnbestimmung. Wiesbaden, 1885. 8 + 184 p. 8vo. 6.40

—— Same. Abtheilg. 2: Berechnung der Finsternisse. Meteorbahnen. Stellastronomie. Wiesbaden, 1885. 8 + 168 p. 8vo. 5.60

Jahrbuch (Berliner Astronomisches) für 1887, mit Ephemeriden der Planeten 1–237 für 1885. Hersg. v. der Sternwarte, unter Leit. v. F. Tietjen. Berlin, 1885. 8 + 480 + 51 p. 8vo. 12

Jahrbuch (Nautisches), oder Ephemeriden und Tafeln für das Jahr 1888 zur Bestimmung der Zeit, Länge u. Breite zur See nach astronomischen Beobachtungen. Hersg. vom Reichsamt des Innern. Berlin, 1885. 8vo. 1.50

Jordan (W.).—Grundzüge der astronomischen Zeit- und Ortsbestimmung. Berlin, 1885. 7 + 390 p. 8vo. zahlr. Holzschn. 10

Jornal de Sciencias Mathematicas e Astronomicas, publ. p. F. Gomes Teixeira. Vol. IV. Coimbra, 1883–'84. 192 p. 8vo. 14

Cont.: Da Silva, Formules nouvelles s. les racines des équations algebraiques; Rodrigues, La formula de Lagrange; Pereira, Sobre algunas intergraes indefinitas. Monteiro, Mémoires de géométrie, etc.

Journal de Mathématiques élémentaires et spéciales. Dirig. p. J. Bourget et Koehler. Année 1885 (12 nrs.). Paris, 1885. 8vo. 15

Journal de Mathématiques pures et appliquées fondé p. Liouville et rédig. p. Résal. Année 1885. (Série III, Tome XI, en 12 nrs.) Paris, 1885. 4to. 27

Journal für die reine und angewandte Mathematik. Hersg. v. L. Kronecker u. K. Weierstrass. Berlin, 4. Jahrg. 1885. Band 98 u. 99. (8 Hefte.) Jeder Band 12.

Journal of the Liverpool Astronomical Society. Vol. III. (October, 1884, to September, 1885.) Liverpool, 1885. 8vo.

Kempf (P.).—Meteorologische Beobachtungen in den Jahren 1881 bis 1883 auf dem Astrophysikalischen Observatorium bei Potsdam. Leipzig, 1885. 147 p. 4to. 7

Klee (F.).—Unser Sonnensystem. 2, mit einem Nachtrag versehene Aufl. Mainz, 1885. 8vo. 1.75

Knowledge, an illustrated magazine of science, art, and literature. Edit. by R. A. Proctor. Vol. V, 1885. (52 nrs.) London, 1885. 4to. 11

Koch (K. R.).—Ueber eine Methode, die Mikrometerschraube zu prüfen. (Leipz., Ann. d. Phys.) 1883. 2 p. 8vo. 0.30

Kowalski (M.).—Observations des étoiles de la zone entre 75° et 80° de déclinaison boréale, exécutées à l'Observatoire de l'Université Impériale de Kasan. Tome I. Kasan, 1885. 10 + 739 p. 4to.

Krueger (A.).—Zonenbeobachtungen der Sterne zwischen 55 u. 65 Grad nördlicher Declination angestellt an den Sternwarten zu Helsingfors u. Gotha. Band II: Enthält die Zonen 339 bis 722 nebst den mittleren Oertern der Sterne für 1875. Helsingfors, 1885. 32 + 400 p. 4to. cart. 20

—— Same. Band I: Enthält die Zonen 1–338 nebst den mittleren Oertern der Sterne für 1875. 20

Lamont (J.).—Astronomisch-geodätische Bestimmungen, ausgeführt an einigen Hauptpunkten des bayerischen Dreiecksnetzes. München, 1885. 8vo. 3

Langley (S. P.).—Researches on solar heat and its absorption by the earth's atmosphere. Report of the Mount Whitney expedition, prepared under the direction of W. B. Hazen. Washington, 1885. 242 p. 4to. (Maps, plates, and woodcuts.)

Langley (S. P.). Experimental determination of wave-lengths in the invisible prismatic spectrum. *Mem. Nat. Acad.*, 2: 149–162. (1884.)

—— Observations on invisible heat-spectra and the recognition of hitherto unmeasured wave-lengths, made at the Allegheny Observatory. 4 pl. *Am. J. Sc.*, 31: 1–12. (1886.)

Lersch (B. M.).—Ueber die symmetrischen Verhältnisse des Planeten-Systems. Neue vollständig umgearb. Aufl. zweier 1879–'80 erschienenen Abhandlungen. Köln, 1885. 59 p. 8vo. 1.60

von Littrow (C. L.).—Wunder des Himmels. 7. Aufl., bearb. v. E. Weiss. Berlin, 1885. 8vo. Liefg. 34–42. Jede Liefg. 0.50

Lorenzoni (G.).—L'Insegnamento di Astronomia e Meteore del prof. L. Riva, e i Documenti relativi alla Fondazione dell'Osservatorio astronomico di Padova. Padova, 1885. 44 p. 8vo.

Lynn (W. T.).—Celestial motions; a handy book of astronomy. 3 ed. London, 1885. 80 p. 16mo. 1.70

von Mädler (J. H.).—Der Wunderbau des Weltalls oder populäre Astronomie. 8. Aufl. Strassburg, 1885. Liefg. 5–12. 8vo. Jede Liefg. 1

Mahler (E).—Astronomische Untersuchung über die in der Bibel erwähnte ägyptische Finsterniss. Wien, 1885. 15 p. 8vo. 0.50

——Die centralen Sonnenfinsternisse des 20. Jahrhunderts. Wien, 1885. 40p. 4to. 2

Marie (M.).—Histoire des Sciences mathématiques et physiques. Tome VII: De Newton à Euler (Suite). Paris, 1885. 272 p. Roy. 8vo. 5.50

—— Same. Tomes I à VI: De Thales à Euler. 35.50

Maxwell.—The life of J. C. Maxwell, with selections from his correspondence and occasional writings, by L. Campbell and W. Garnett. New edition, abridged and revised. London, 1885. 8vo. (Portrait and illustr.) Cloth. 7.80

Mayer (J.).—Sternkarte mit beweglichem Horizont. Apparat zum Studium des Gestirnten Himmels mit zugehöriger Astrognosie oder Anleitung zur Kenntniss der Gestirne. Schaffhausen, 1885. Fol. m. 3 Tfln. In Mappe. 4

Mélanges Mathématiques et Astronomiques tirés du Bulletin de l'Académie Impériale des Sciences de St.-Pétersbourg. Tome VI. Livr. 3. St.-Pétersbourg, 1885. Roy. 8vo. 1

—— Same. Tome VI. Livr. 1 et 2. 1884. 4

Memoirs of the National Academy of Sciences. Vol. II. Washington, 1884. 262 p. (with plates.) 4to.

Cont.: Report of the eclipse expedition to Caroline Island. Langley, Experimental determination of wave-lengths in the invisible prismatic spectrum. Brewer, On the subsidence of particles in liquid. Bell, On the formation of a deaf variety of the human race.

Merriman (M.).—Text-book of the method of least squares. London, 1885. 8vo. Cloth. 9

Mitchell (O. M.).—The orbs of heaven; or planetary and stellar worlds. New edit. London, 1885. 300 p. 8vo. Cloth. 2.30

Mittheilungen (Mathematische u. naturwissenschaftliche) aus den Sitzungsberichten der königl. Preuss. Akademie der Wissenschaften zu Berlin. Jahrgang 1885. Berlin. 8vo. Tfln. 8

Möbius (A. F.).—Gesammelte Werke. Auf Veranlassung der kgl. Sächsischen Gesellschaft der Wissenschaften herasg. v. R. Baltzer, F. Klein u. W. Scheibner. (In 4 Bänden.) Band I: Barycentrischer Calcul, herasg. v. R. Baltzer. Leipzig, 1885. Lex. 8, m. Bildniss (v. Möbius) u. 132 Holzschn. 16

Band II wird enthalten: Analytische Sphärik u. sonstige geometrische Untersuchungen.

Band III u. IV: Untersuchungen auf d. Gebiete d. Statik u. d. himmlischen Mechanik.

Moscow Observatory.—Annales de l'Observatoire de Moscou. Publiées par Th. Bredichin. Vol. x, livraison 2. Moscou, 1884. 164 p., 7 pl. 4to. 8

Cont.: Belopolsky, Observat. au Cercle méridien. Essai d'une déterminat. du rayon appar. du soleil au moyen de la photographie. Observat. photohéliograph. en 1883. Joukovsky, Sur la construct. des courbes syndynam. et synchron. Bredichin, Les syndynames et les synchrones de la Comète Pons-Brooks. Avec note supplém. Sur la queue du I. type de la Comète de 1744. Socoloff, Näherungsformeln der Theorie der Cometenschweife. Ceraski, Ueber die Berechnung des Lichtverhältnisses f. Sterne von auf einander folgenden Grössenklassen.

—— La 1 série des "Annales" complète en 10 volumes. 120

Munich Observatory.—Annalen der Münchener Sternwarte. Supplementband 10. München, 1885. 8vo. 3

Cont.: Astronomisch-geodätische Bestimmungen ausgeführt an einigen Hauptpunkten des bayerischen Dreiecksnetzes u. herag. v. J. v. Lamont.

Nachrichten (Astronomische) begründet v. H. C. Schumacher. Unter Mitwirkung der Astronomischen Gesellschaft herag. v. A. Krüger. Kiel, 1885. 4to. Band 112. (24 Nrn.) 15

—— Band 113. (24 Nos.) 15

Nasmyth (J.) and **Carpenter** (J.).—The moon; considered as a planet, a world, and a satellite. New York, Scribner & Welford, 1885. 16+213 p., 26 pl., illustr. 8vo.

National Academy of Sciences.—Memoirs of the National Academy of Sciences. Vol. ii. 1883. Washington, 1884. 262 p., 7 pl. 4to.

Cont.: Report of the eclipse expedition to Caroline Islands, May 1883. Langley, Experimental determination of wave-lengths in the invisible prismatic spectrum.

Nature.—A weekly illustrated journal of science. Year 1885. (52 nrs.) London, 1885. 31+640 p. 4to. 30

Nature (La).—Revue illustrée des Sciences et de leur Application aux Arts et à l'Industrie. Réd. p. G. Tissandier. Année 1885. (2 vols. en 52 nrs.) Paris, 1885. 4to. 20

Newcomb (S.).—Development of the perturbative function and its derivatives, in sines and cosines of multiples of the eccentric anomaly, and in powers of the eccentricities and inclinations. *Astron. Papers Am. Ephem.*, 3: 1–200 (vol. 3, part 1, 1884). 10

—— Measures of the velocity of light made 1880–'82. Michelson (A.), Supplementary measures of the velocities of white and colored light in air, water, and carbon disulphide. *Astron. Papers Am. Ephem.*, 2: 113–258 (vol. 2, parts 2 and 3, 1885). 7.50

—— On the motion of Hyperion. A new case in celestial mechanics. *Astron. Papers Am. Ephem.*, 3: 347–371 (vol. 3, part 3, 1884).

—— Catalogue of 1098 standard clock and zodiacal stars. *Astron. Papers Am. Ephem.*, 1: 147–314 (vol. 1, part 4, 1884.) 15

—— The essentials of trigonometry, plane and spherical, with 3 and 4 place logarithmic and trigonometric tables. New York, 1885. 12mo. Cloth. 6.30

Observatory (The).—Monthly journal of practical astronomy. Year 1885. (12 nrs.) London, 1885. 9+444 p. 8vo. 14

Oertel (K.).—Astronomische Bestimmung der Polhöhen auf den Punkten Irschenberg, Höhensteig u. Kempenwand. München, 1885. 4to. 2

O'Gyalla Observatory.—Beobachtungen angestellt am astrophysikalischen Observatorium in O'Gyalla. herag. v. N. v. Konkoly. Band 8. Halle, 1885. 4to. 5 Holzschn. u. 2 lithogr. Tfln. 10

Oppenheim (S.).—Ueber die Rotation und Präcession eines flüssigen Sphäroids. Wien, 1885. 47 p. 8vo. 0.80

——— Bahnbestimmung des Kometen VIII, 1881. Wien, 1885. 8vo. 0.50

OPPERT (J.).– Die astronomischen Angaben der Assyrischen Keilinschriften. Wien, 1885. 13 p. 8vo. 0.30

VON OPPOLZER (TH.).—Ueber die Auflösung des Kepler'schen Problems. Wien, 1885. 59 p. 4to. 3.20

——— Ueber die Länge des Siriusjahres und der Sothisperiode. Wien, 1885. 28 p. 8vo. 0.50

PACIFIC SCIENCE MONTHLY. Vol. I., No. 1. San Buenaventura (Cal.), 1885. 12 p. 8vo.

PARIS OBSERVATORY.—Annales de l'Observatoire de Paris, publ. sous la direct. de Mouchez. Observations (1881). Paris, 1881. 8+758 p. Roy. 4to. 33.50

——— Mémoires. Tome 18. Paris, 1885. 311 p. Roy. 4to. 23

PETERS (C. F. W.).—Die gegenseitige Lage der Sternwarten zu Altona u. Kiel. Berlin, 1884. 4to. 1.50

PHILOSOPHICAL MAGAZINE and Journal of Science, cond. by R. Kane, W. Thomson, W. Francis. Year, 1885 (12 nrs.). London. Roy. 8vo. 32

PHILOSOPHICAL SOCIETY of Washington. Bulletin, vol. VIII. Washington, 1885. 47+68 p. 8vo.

PHILOSOPHICAL TRANSACTIONS of the Royal Society for 1884. Part ii. London, 1885. 4to, with 28 plates. 37.50

Cont.: Heath, On the dynamics of a rigid body in elliptic space. Hartley, Researches on spectrum photography. II. Poynting, On the transfer of energy in the electro-magnetic field. Hill, On the motion of fluid, part of which is moving rotationally and part irrotationally. Rayleigh, On the electrochemical equivalent of silver and on the absolute electro-motive force of Clark cells. Ramsay and Young, Influence of change of condition from the liquid to the solid state on vapor pressure. Ferrier and Yeo, Record of experiments on the effects of lesion of different regions of the cerebral hemispheres. Bower, On the comparat. morphology of the leaf in the vascular cryptogams and gymnosperms. Dixon, Condition of chemical change in gases.

PICKERING (E. C.).—Observations of variable stars in 1884. *Proc. Am. Acad.*, 20: 393–406. (1885.) 8vo.

——— Annals of the Astronomical Observatory of Harvard College. Vol. XIV. Cambridge, 1885. 512 p. Roy. 4to.

——— Report (40th annual) of the director of the Astronomical Observatory of Harvard College. Cambridge, 1886. 13 p. 8vo.

——— A photographic study of the Nebula of Orion. *Proc. Am. Acad.*, 20: 407. (1885.)

PROCTOR (R. A.).—The universe of suns, and other science gleanings. New York, 1885. 401 p. 12mo. Cloth. 11.20

——— Lo Spettroscopio e le sue Applicazioni. 1. traduz. italiana c. note ed aggiunte di F. Porro. Milano, 1885. 5+178 p. C. 71 incis. e carta (di spettri). 16mo. 1.50

POTSDAM OBSERVATORY.—Publicationen des Astrophysikalischen Observatoriums zu Potsdam. Nr. 15 (Band IV, Stück 2): Meteorologische Beobachtungen in den Jahren 1881 bis 1883. Bearbeit. v. P. Kempf. Leipzig, 1885. 447 p. 4to. 7

——— Publicationen des Astrophysikalischen Observatoriums zu Potsdam. Nr. 16 (Band IV, Stück 3): Ueber den Einfluss der Temperatur auf die Brechung des Lichtes in einigen Glassorten, im Kalkspath u. Bergkrystall, v. G. Müller. Potsdam, 1885. 65 p. 4to. 4

———. Same. Nr. 1–15, 1878–'85, m. 63 Tfln. 84

QUARTERLY JOURNAL of pure and applied mathematics. Edited by N. M. Ferrers, A. Cayley, J. W. L. Glaisher, A. R. Forsyth. No. 80. (Vol. XX, pt. 4.) London, 1885. P. 289–383, title p., index, 1 plate. 8vo. 5.20

——— No. 81. (Vol. 21, pt. i.) London, June, 1885. p. 1–96, with 1 plate. 5.20

——— No. 82. (Vol. 21, pt. ii.) Cambridge, 1885. p. 97–192. 5.20

RADCLIFFE OBSERVATORY, Oxford, results of astronomical and meteorological observations in the year 1881. Vol. 39. Oxford, 1884. Roy. 8vo.

——— Results of astronomical and meteorological observations in the year 1882. Vol. 40. Oxford, 1884. 20+130+4 p. Roy. 8vo.

Respighi (L.).—Catalogo delle Declinazioni medie pel 1880, o di 1004 Stelle. Roma, 1885. 4to. 3.80

——— Sulle Osservazioni del Bordo e delle Protuberanze Solari fatte al R. Osservatorio del Campidoglio. Nota viii. Roma, 1885. 44 p. 4to. 6.80.

Roberts (F. C.).—The figure of the earth. New York, 1885. 95 p. 12mo. 2.50

Rogers (W. A.).—Catalogue of 1,213 stars observed at the Astronomical Observatory of Harvard College with the meridian circle 1870–'79. Cambridge, Mass., 1884. 7+93 p. 4to.

Roscoe (H. E.).—Spectrum analysis. 4th ed., revised and considerably enlarged by the author and A. Schuster. London, 1885. Roy. 8vo. Cloth. 21

Schellen (H.).—Spectrum analysis in its application to terrestrial substances, and the physical constitution of the heavenly bodies. Translated from the 3d enlarged and revised German edition by J. and C. Lassell. Edited with notes by W. de W. Abney. London, 1885. With 291 wood cuts and 14 plates (5 colored). 8vo. Cloth. 32.50

Science.—An illustrated journal, published weekly. Cambridge, Mass. Year 1885 (Vols. v, vi) in 52 nrs. 4to. Illustr. 26

Searle (A.).—The apparent position of the zodiacal light. *Mem. Am. Acad.*, 19: 135–157 (1885).

Secchi (A.).—L'Unità delle Forze Fisiche. Saggio di Filosofia Naturale. 4. ediz. (3 italiana), preceduta dalla biografia del A. Secchi, per F. Denza. 2 vol. Milano, 1885. 408+387 p. 16mo. 5.50

——— Il Sole; esposizione delle principali Scoperte moderne sopra la sua Struttura, la sua Influenza nell' Universo e le sue Relazioni cogli altri Corpi celesti. Firenze, 1885. 8+439 p. 8vo. 9

Seeliger (H.).—Die Vertheilung der Sterne auf der nördlichen Halbkugel nach d. Bonner Durchmusterung. (München), 1885. 29 p. 8vo. 1.20

Servus (A.).—Untersuchungen über die Bahn und die Störungen der Himmelskörper mit Zugrundelegung des Weber'schen elektrodynamischen Gesetzes. Halle, 1885. 47 p. 4to. 2

Sidereal Messenger (The).—Conducted by W. W. Payne. Vol. 4. Northfield, 1885. 320 p. 8vo.

Sirius.—Zeitschrift für populäre Astronomie. Red. H. J. Klein. Bd. 18 (Neue Folge, Bd. 13). Jahrg. 1885. (12 Hefte.) Leipzig, 1885. 4+288 p. 8vo. 10

Sitzungsberichte der kaiserl. Akademie der Wissenschaften. Mathematisch-naturwissenschaftliche Classe. Band 90, Heft 3 u. 4. Abtheilg. 2. Wien, 1885. p. 387–779. 8vo. 6

Abtheilg. 2: Abhandlungen aus dem Gebiete der Mathematik, Physik, Chemie, Mechanik, Meteorologie u. Astronomie.

——— Mathematisch-naturwissenschaftliche Classe. Abtheilg. 2: Abhandlungen aus dem Gebiete der Mathematik, Physik, Chemie, Mechanik, Meteorologie u. Astronomie. Band 91, Jahrgang 1885. Heft i u. ii: Januar u. Februar. Wien, 1885. P. 1–393. 8vo. 5.50

Sitzungsberichte der mathematisch-physikalischen Classe d. k. bayr. Akademie der Wissenschaften zu München, 1884. Heft iv. München, 1885. p. 1—6, 521—654, m. 3 Tfln. 8vo. Jedes Heft. 1.20

——— Band 14, 1884, jetzt complet. 4.80

Stern-Ephemeriden für das Jahr 1887. Herausg. v. d. Berl. Sternwarte. Berlin, 1885. 8vo. 6

Struve (O.).—Tabulæ quantitatum Besselianarum pro annis 1885 ad 1889 computatæ. Petropoli, 1885. 8vo. 1.20

Thomson (W.).—Tafeln zur Erleichterung der Anwendung der Sumner'schen Methode. Neu berechnet v. M. Bozek u. A. Portner v. Höflein. Triest, 1885. fol. 2.

Tyerman (T. F.).—The moon's rotation examined by the Newtonian theory of gravitation. Oxford, 1885. 32 p. 8vo. Cloth. 2.20

Unification des Longitudes par l'adoption d'un Méridien initial unique et introduction d'une Heure universelle. Extrait des Comptes rendus de la 7. Conférence générale de l'Association Géodésique internationale, réunie à Rome en Octobre 1883. Berlin, 1884. 4to. 3

United States Naval Observatory.—Astronomical and meteorological observations made during the year 1881. Washington, 1885. 74 + 202 + 21 + 33 + 27 p. 4to.

Vierteljahrsschrift der Astronomischen Gesellschaft. Hersg. v. E. Schönfeld u. H. Seeliger. Jahrg. 19. Heft IV. Leipzig, 1884. p. 237-300, Titel u. Inhaltsverz. 8vo. 2

—— Jahrg. 20. Heft 1 to 4. Leipzig, 1885. 4 + 342 p. 8vo. Jedes Heft. 2

Vierteljahrsschrift der Naturforschenden Gesellschaft in Zürich. Redig. v. R. Wolf. Jahrgang 30. Zürich, 1885. 8vo. 3.60

Cont.: Nr. 1 (p. 1-128): Wolf, Astronom. Mittheilungen. Graberg, Ueber Masszeichen. Haller, Beitr. z. Kenntniss d. Schweizerischen Milbenfauna, &c.

Vogel (H. W.).—Die Photographie nach farbigen Gegenständen in den richtigen Tonverhältnissen. Berlin, 1885. 8 + 157 p. 1 Farbendruckbeilage, 2 danach gefertigten Photographien u. 15 Holzst. 8vo. 4

Washburn Observatory.—Publications of the Washburn Observatory of the University of Wisconsin. (E. S. Holden, Director.) Vol. III. Madison, 1885. 139 p. 8vo.

Webb (T. W.).—The sun; a familiar description of his phenomena. London, 1885. Plates and 17 diagrams. 8vo. 1.20

Weiss (E.).—Entwickelungen zum Lagrange'schen Reversionstheorem u. Anwendung derselben auf die Lösung der Kepler'schen Gleichung. Wien, 1885. 8vo. 0.60

—— Entwickelungen zum Lagrange'schen Reversionstheorem u. Anwendung derselben auf die Lösung der Keppler'schen Gleichung. Wien, 1885. 38 p. 4to. 2

Williams (W. M.).—The fuel of the sun. London, 1885. 244 p. 8vo. cloth. 7.80

Wochenschrift für Astronomie, Meteorologie u. Geographie. Redig. v. H. J. Klein. Jahrg. 1885 (52 Nrn.). Halle, 1885. 8vo. 9

Young (C. A.).—Theories regarding the sun's corona. *N. Am. Rev.* (1885).

Zeitschrift für Instrumentenkunde. Organ für Mittheilungen aus dem gesammten Gebiete der wissenschaftlichen Technik. Red. v. G. Schwirkus. Zahlr. Originalabbildgn. Jahrg. 5, 1885 (12 Hefte). Berlin, 1885. 4to. 18

Zeitschrift für mathematischen und naturwissenschaftlichen Unterricht, hersg. v. J. C. V. Hoffmann. Jahrg. 16, 1885 (6 Hefte). Leipzig, 1885. 8vo. 12

Zeitschrift für Mathematik und Physik, hersg. v. O. Schlömilch, E. Kahl u. M. Cantor. Jahrg. 30, 1885 (6 Hefte). Leipzig, 1885. 8vo. 18

NECROLOGY OF ASTRONOMERS: 1885.

Baeyer (*Gen.* J. J.), President of the Central Bureau for European Triangulation and of the Royal Prussian Geodetic Institute; b. November 5, 1794; d. September 10, 1885.

von Boguslawski (Georg); b. December 7, 1827; d. May 4, 1884.

Clausen (Th.), Director emeritus of the Dorpat Observatory; d. May 25, 1885.

Folain (———), Assistant astronomer at the Paris Observatory; b. 1828; d. at Paris, May 26, 1885.

Hartnup (John), Superintendent of the Liverpool Observatory; b. January 7, 1806; d. October 20, 1885.

Hohwü (Andreas), Chronometer-maker, Amsterdam; d. September 28, 1885, æt. 82.

Sidebotham (Joseph); b. January 17, 1824; d. May 24, 1885.

Webb (*Rev.* Thomas William); b. December 14, 1807; d. May 19, 1885.

Wray (William), Optician; b. December 6, 1829, d. ———, 1885.

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RECORD OF SCIENCE FOR 1886.

ASTRONOMY, FOR 1886.

By WILLIAM C. WINLOCK,
Assistant Astronomer, United States Naval Observatory.

In preparing the review of Astronomy for 1886, the method and arrangement adopted by Professor Holden from 1879 to 1884 have been adhered to without essential modification. The record is intended primarily to serve as a series of notes for those who have not access to a large astronomical library, but it is hoped that the bibliography will be found useful to the professional astronomer as a reference list of technical papers.

Much assistance has been derived from the reviews and abstracts in the Bulletin Astronomique, the Observatory, Nature, the Athenæum, and other periodicals, and the writer is indebted to the directors of many observatories for the communication of information not otherwise available.

A subject-index to the review has been effected by inserting the necessary page-references in the bibliography.

DISTRIBUTION OF STARS.

Distribution of the stars in Schönfeld's Durchmusterung.—The completion of the Durchmusterung to − 23° of declination by Argelander's successor, Dr. Schönfeld, has given Professor Seeliger the opportunity of extending his counts of stars to a considerable portion of the southern hemisphere. Professor Seeliger's paper "Über die Vertheilung der Sterne auf der südlichen Halbkugel nach Schönfeld's 'Durchmusterung,'" has been published in the Proceedings of the Bavarian Academy of Sciences, and résumés may be found in the Bulletin astronomique (3:593–6), the Observatory (9:399), and Nature (34:627). An abstract of Professor Seeliger's previous work was given in the "Account of the Progress in Astronomy" for 1884, and his present discussion has been carried out on a plan similar to that there described.

sive, the totals are, for the former, 34,324, and for the latter, 34,119, a difference which may reasonably be attributed to accidental circumstances.

The whole discussion of the distribution of the stars will no doubt be much facilitated by the application of photography.

A writer in L'Astronomie has concluded that the total number of stars in "our nebula"—on the assumption that the combined light of the stars is equal to one-tenth that of the full moon—must be sixty-six thousand million.

NEBULÆ AND STAR CLUSTERS.

New nebulæ.—Two lists, embracing 476 new nebulæ discovered with the 26-inch equatorial of the Leander McCormick Observatory, have been published in the Astronomical Journal (7: 9, 57) by Professor Stone. The observers were Professor Stone himself, Mr. Leavenworth, and Mr. Muller. In the earlier observations Herschel's abbreviations were used to designate brightness and size. Afterwards numerical magnitudes were employed to indicate brightness, assuming that the faintest nebula visible in the 26-inch refractor with power 167, is 16.3, that being the theoretical limit for stars. The magnitudes given refer to the nucleus, or, in case there is no nucleus, to the brightest part. Still later the custom was instituted of estimating the diameters of the nebulæ in fractions of the diameter of the field, and from these deducing their dimensions in minutes of arc.

Dr. Swift has published (Astron. Nachr., 115: 153, 257; 116: 33) catalogues 3, 4, and 5 of nebulæ discovered at the Warner Observatory. He states in the report of the observatory that 540 nebulæ have been discovered up to January 1, 1887. Mr. Muller has found that fifteen of "Catalogue No. 5" have already been announced by other observers. (Sid. Mess., 6: 83.)

The Pleiades.—M. Rayet, in order to test the penetrating power of the 14-inch Bordeaux equatorial, has made a revision of Wolf's chart of the Pleiades, and has determined accurately the positions of 143 stars, most of them of the fourteenth or fifteenth magnitude, not given by Wolf.

The Henry brothers have also compared their photographs of the Pleiades with Wolf's chart, and have been able to detect 1,421 stars where Wolf shows but 625, the telescopes used being of nearly the same aperture. In order to avoid errors which might arise from impurities in the photographic plate, three exposures, of an hour each, were made, and the plate was shifted between exposures, so that three images of each star are obtained, forming an equilateral triangle. Stars as faint as the sixteenth magnitude are depicted. All the stars of Wolf's chart are found upon the photograph except ten, and these the Messrs. Henry have been unable to find in the sky. A number of faint companions have been detected close to several of the brightest stars of the group, and in several cases where M. Wolf has observed a faint companion to a bright star, the photograph has shown that the magnitude of the former was underestimated. One of the advantages of photography seems to be that it brings out faint objects which are lost to the eye, on account of their proximity to bright stars. Besides the nebula discovered about Maïa, a nebulous streak has been seen near Electra, and details of the Merope nebula have been made out, which had not been recognized before, except by Common.

Dr. Weiss has expressed a strong suspicion that all of the region to the north and west of Alcyone is a vast nebula, only the brightest portions of which are shown by our best telescopes. He recalls a statement by Schmidt in 1863, that a small planet seemed to lose a part of its light in traversing the region between Alcyone and Electra.

Dr. Kammermann has been able to see the new Maïa nebula with the 10-inch refractor of the Geneva Observatory by masking the bright star, and by using a special eye-piece provided with diaphragms, and a plate of uranium glass, to increase the intensity of the chemical rays.

A paper by Dr. Elkin upon "A comparison of the places of the Pleiades as determined by the Königsberg and Yale College heliometers" was read at the Buffalo meeting of the American Association. Provisional results show unquestioned change of position with reference to η Tauri since 1840. Most of the brighter stars of the group, as shown by Newcomb in his "Standard Stars," go with η Tauri, but among the smaller stars there are departures from this community of proper motion. Professor Pickering has pointed out that the agreement of the spectra of certain of these stars strongly confirms the probability of their physical connection.

ASTRONOMICAL CONSTANTS.

Lœwy's method of determining the elements of refraction.—M. Lœwy has elaborated his method of determining the elements of refraction by means of a reflecting prism placed in front of the object-glass of an equatorial, and has submitted the problem to a careful mathematical analysis in several papers communicated to the French Academy. The full titles of these important papers are given in our "biobligraphy." Dr. Gill speaks very highly of the plan, and has suggested some modifications of the details which he thinks would increase the ease and accuracy of observations.

Oppolzer's astronomical refraction.—The late Dr. von Oppolzer published in the Transactions of the Imperial Academy of Sciences, of Vienna, a paper containing a theoretical discussion of the problem of astronomical refraction followed by numerical tables intended to facilitate the practical application of the results at which he arrived. When the approximations are carried far enough, the method seems capable of giving results of great accuracy, even for large zenith distances.

A correction for gravity in the use of refraction tables.—Prof. Cleveland Abbe has directed attention to a neglected correction in the use of refraction tables, which appears as a function of the latitude. Thirty inches of mercury in the barometer at the equator indicate a less density of the atmosphere than 30 inches at the poles, consequently the barometer readings should be corrected for differences of latitude. This is accomplished by simply adding to the formula one more factor for gravity. Professor Abbe shows that the difference of latitude between Pulkowa and Washington makes a difference of 0″. 1 in the refraction at 45° zenith distance, and increases with the zenith distance. We have here a partial explanation, at least, of systematic differences in declination shown by different catalogues.

Correction for differential refraction in declination.—Professor McNeill, of Princeton, has devised (Astron. Nachr., 114:385) a method of correcting micrometer observations for refraction, applicable to the diagonal-square micrometer, the ring micrometer, and others of the same class. The correction to the observed difference of declination is not determined by a special separate computation, but the true difference is directly determined, the corrections being applied to the logarithms in the course of the computation. Tables are given which will be found very useful to observers.

In a "Zusatz" to this communication, Dr. Krueger gives a résumé of differential refraction formulæ for ring and filar micrometers.

M. Radau suggests (Bull. astron., 3:373) that Professor McNeill's principal table may be replaced by a simple graphical table which will give at a glance the correction sought.

The diurnal nutation of the earth's axis.—M. Folie, about three years ago, submitted to the Paris Academy a theory of the diurnal nutation of the earth's axis, based upon the assumption that the earth has a fluid nucleus; and he has recently given (Compt. Rend., Dec. 13, 1886) some practical illustrations of his formulæ. These formulæ contain two constants to be determined by observation: the constant of diurnal nutation itself, and the longitude, referred to an initial meridian. Very accordant results are obtained from the rather meager observational material available, the value of the diurnal constant being about 0″.2. The new correction applied to a series of observations of Polaris made at Pulkowa, smooths out the discordant observations in a most surprising manner. Further investigation of this subject seems highly desirable.

An abstract of the paper read by Prof. J. C. Adams at the Philadelphia meeting of the American Association, September 11, 1884, "On the general values of the obliquity of the ecliptic, and of the precession and inclination of the equator to the invariable plane, taking into account terms of the second order," has appeared in the Observatory for April, 1886, vol. 9, p. 150–154.

STAR CATALOGUES, ETC.

Schönfeld's Southern Durchmusterung (1855.0).—This catalogue contains the approximate positions of 133,659 stars between 2° and 23° of south declination—that is, all stars between those limits down to the tenth magnitude. It carries Argelander's "sweeps" as far south as the latitude of Bonn will permit, and is on essentially the same plan as the Northern Durchmusterung. In the details of the work, however, several improvements have been made: Instead of Argelander's little 3-inch glass, magnifying nine times, Dr. Schönfeld used a telescope by Schröder of 6¼ inches aperture with a magnifying power of twenty-six, and with the field slightly illuminated. The width of the zones was 1½°, instead of 2°, the width of the older zones. This involved more hours of observation, but the accuracy of the work and the certainty of catching faint stars were increased, since the observer was not obliged to take in everything up to the limit of visibility. A further advantage which the Southern Durchmusterung possesses is that Dr. Schönfeld has himself made all of the observations and revisions, so that the work is more homogeneous than the Northern Durchmusterung. The observations were begun, after some preliminary experiments, on the 6th of June, 1876; by the 28th of March, 1881, the zones had all been observed for the second time. There are, including sixteen zones subsequently re-observed, 363,922 observations, all reduced to 1855.0. The revision, also by Dr. Schönfeld and with the same instrument, embraced 5,700 positions, and was finished between April, 1881, and March, 1884.

From the summary of the stars in each square degree it appears that the Southern Durchmusterung is richer in stars than the Northern, in the ratio of 1.21 to 1. The fainter stars (under the ninth magnitude) are much more thoroughly observed than before, the limit being the tenth magnitude instead of 9.5, that adopted by Argelander. The probable error of a single estimation of magnitude for stars of the 9.5 magnitude is only 0.11 magnitude, and for the seventh magnitude, 0.26 magnitude. The charts accompanying the catalogue contain an hour each in right ascension.

The Argentine General Catalogue.—The observations from which this catalogue was formed were made with the meridian circle of the Cordoba Observatory during the years 1872–'80. During these years the zone observations were the chief object of attention, and the catalogue contains the places of 32,448 stars whose positions were more elaborately determined during the progress of that great work, and constitutes an addition to our knowledge of southern stellar positions of perhaps not less importance than the Cordoba Zone Catalogue. The General Catalogue gives the positions for the epoch 1875.0 of most of the southern stars brighter than magnitude 8¼, the deficiencies in this respect being chiefly found north of the parallel of 23°, at which the zone begins. These omissions will be of comparatively small importance, inasmuch as the Durchmusterung of Professor Schönfield comprises all the southern stars within this region, while accurate determinations of the brighter ones will have been made in the re-observation of Lalande's stars now nearly completed at the Paris Observatory.

Pulkowa catalogue of 3,542 *stars for* 1855.0.—Volume VIII of the Pulkowa Observations is to contain two catalogues of stars deduced from observations made with the meridian circle from 1840 to 1869. The first of these—the one that has just been published—contains, with the exception of the Pulkowa fundamental stars (observed with the transit instrument and vertical circal), all Bradley's stars between the north pole and 15° south declination, and also a comparatively small number of other stars down to the sixth magnitude, inclusive, given in the *Uranometria Nova* of Argelander, in the same part of the sky. A few fainter stars have also been taken into the catalogue. The whole work has been in the hands of Dr. Backlund. (Bull. astron., November, 1886.)

Kam's catalogue of "Nachrichten" stars for 1855.0.—"Dr. N. M. Kam of Schiedam has published in Verhandelingen der Koninklijke Akademie van Wetenschappen, Deel. 24 (Amsterdam), a star catalogue compiled from the places of stars determined by meridian observations, which have been extracted from volumes 1 to 66 of the Astronomische Nachrichten, and reduced to the epoch 1855.0. The positions of the stars contained in this catalogue were determined in connection with observations of planets and comets, and it was in compliance with Argelander's express desire that the work of collecting them and reducing the positions to a common epoch was commenced by Hoek, then director of the Utrecht Observatory. Dr. Kam, who was Hoek's assistant, continued the work after the death of the latter, and has at length been able to publish his results. The principal catalogue contains the completely determined places of 4,350 stars, and is followed by two subsidiary catalogues, the first giving the places of 236 stars, and the second those of 335 stars; all of the latter, however, are incomplete, *i. e.*, the place is given in one element only. The catalogues are followed by a comparison of the places of the stars contained in them with their places as given in the Bonn Durchmusterung, or, for stars south of — 2° declination, with other authorities. Notes on proper motions, corrigenda, etc., are appended, which are of considerable interest and value." (Nature, June 3, 1886.)

Romberg's catalogue of "Nachrichten" stars (1855.0).—Herr Romberg, of the Pulkowa Observatory, has compiled a catalogue of about 8,000 stars extracted from the Astronomische Nachrichten, volumes 67 to 112, and his work now appears as Publication XVIII of the Astronomische Gesellschaft. This is a continuation of a similar compilation (Pub. VIII, Astron. Gesellsch.), by Schjellerup, from the first sixty-six volumes of the Nachrichten, and is prepared on much the same plan. The stars have appeared in the Nachrichten as comparison stars for planets, comets, etc., and have been collected by Romberg and reduced to 1855.0.

Right ascensions are given to seconds of time, declinations to the nearest tenth of a minute of arc. The catalogue proper is followed by several useful pages of notes.

Edinburgh catalogue.—Prof. Piazzi Smyth has given in volume XV of the Edinburgh Astronomical Observations the results of observations made from 1833 to 1872 upon some 3,890 B. A. C. stars, reduced to the epochs 1830, 1870, 1880, and 1890. The catalogue begins with $4^h\ 0^m$ of right ascension, the first four hours having appeared nine years ago as volume XIV. The notes contain information in regard to the proper motion, color, or duplicity of the stars.

Second Armagh catalogue of 3,300 *stars for* 1875.0.—After the completion of the observations of Bradley's stars, the results of which were embodied in the catalogue commonly known as the "Armagh Catalogue," Dr. Robinson formed the plan of re-observing a number of stars from Lalande's "Histoire céleste," occurring in Baily's catalogue. Observations were commenced in 1859 with the 3⅔-inch mural circle and transit, but were stopped after 1860 in order to change the mural into a 7-inch transit circle. Work was resumed in 1863, and continued with more or less regularity till 1883. The right ascensions of this catalogue depend on the standard stars of the "Nautical Almanac;" the north polar distances upon observations of the nadir. Dr. Dreyer, who succeeded Dr. Robinson in 1882, found from 400 observations of 80 stars between 30° and 100° N. P. D., that the probable error of a single observation in right ascension was $\pm 0^s.081$, (the single errors having been multiplied by $\cos \delta$); and in north polar distance $\pm 0''.85$. For systematic errors Armagh has been compared with Glasgow, and, indirectly through the latter, a comparison is obtained with Auwers' fundamental system. From this comparison it appears that the north polar distances are in fair agreement with Auwers' catalogue, while the right ascensions show considerable discordances.

Reliability of the star-places of Auwers' Fundamental Catalogue.—Mr. Chandler, having pointed out the possibility of error in the places of certain stars (Observatory 8: 387), as given in the Berlin "Jahrbuch," Herr Auwers has been induced to publish (Astron. Nachr., 114: 1–20) some valuable and interesting remarks on the reliability of the places of his Fundamental Catalogue (Pub. d. astron. Gesellsch., 14), from which those given in the Berlin "Jahrbuch" are derived. Herr Auwers explains the provisional character of the data on which some of his star-places depend, and repeats in a more definite manner what he has already said on the subject in Publication XIV. In fact the proper motions adopted for some of the stars are merely provisional, as has been pointed out in the introduction to the catalogue. The proper motions employed have been, as a rule, obtained from a comparison of Bradley's places with those of Greenwich, 1861, and in those cases in which Bradley has only one observation, or observed the star in one element only, the proper motion is given to one decimal place less than usual. The reader is thus put on his guard, and knows that he should use the places of certain stars with circumspection. Herr Auwers thinks that it would be premature to attempt any correction of the catalogue-places before the completion of the general revision, which has been undertaken by the observers of the zones and by the Pulkowa astronomers. He, however, takes this opportunity of publishing the results of investigations he has made as to the mean errors of the different catalogues employed in the formation of the Fundamental Catalogue, viz, Pulkowa, 1845 and 1865; Greenwich, 1861 and 1872; Cambridge (U. S.), 1872; Leipzig, 1868; and Leiden, 1868, for the principal stars; and in addition to these, Pulkowa, 1871, for the supplementary stars.

The following are, in the mean (for declination — 10° to + 90°), the mean errors, referred to the unit of weight, for the principal stars:

	P. 1845.	P. 1865.	G. 1861.	G. 1872.	C. 1872.	Lp. 1868.	L. 1868.
R. A. ($\varepsilon \cos \delta$) . .	$0^{s}.040$	$0^{s}.033$	$0^{s}.038$	$0^{s}.032$	$0^{s}.031$	. . . .	. . . .
Decl. (ε)	$0''.51$	$0''.61$	$0''.55$	$0''.52$	$0''.86$	$0''.46$	$0''.58$

And for the supplementary stars:

	P. 1845.	P. 1871.	G. 1861.	G. 1872.	C. 1872.	Lp. 1868.	L. 1868.
R. A. ($\varepsilon \cos \delta$) .	$0^{s}.043$	$0^{s}.057$	$0^{s}.053$	$0^{s}.034$	$0^{s}.035$	. . . .	. . . .
Decl. (ε)	. . . .	$0''.72$	$0''.64$	$0''.52$	$0''.89$	$0''.72$	$0''.52$

We have then, finally, for mean error of the right ascensions $0^{s}.033$ (for supplementary stars $0^{s}.042$), and for the declinations $0''.59$ (for supplementary stars $0''.67$). The somewhat considerable difference in the results for principal and for supplementary stars arises from the circumstance that Herr Auwers gave relatively too much weight to Pulkowa 1871, at least for the right ascensions. For the catalogue-places, the mean errors are $0^{s}.009$ and $0''.14$ in R. A. and Decl., respectively, for the principal stars, and $0^{s}.026$ and $0''.19$ for the supplementary stars; where the mean error in R. A. refers to the total number of stars between — 10° and + 50°. At the present time, in Herr Auwers' opinion, the probable error of the star-places is not greater than $0^{s}.02$ in R. A. (for moderate declinations), and $0''.15$ in Decl. (Observatory, 9 : 202, May, 1886.)

In response to a suggestion by Dr. Gill, a number of astronomers have expressed their willingness to co-operate in the systematic observation of stars which have been used in comet comparisons, faint stars whose occultations have been observed, zones of stars used for scale or screw values, or stars that have been used for geodetic purposes. Among the observatories ready for this work are, the Cape of Good Hope, Neuchâtel, Bruxelles, Cointe, Taschkent, and Cordoba.

Professor Holden, while at the Washburn Observatory, compiled a list of all published corrections to his star catalogues, inserting the errata in the bodies of the books themselves. The original sources from which the errata were copied are given in the fourth volume of the Publications of the observatory. The value of this list will be appreciated by all astronomers who have occasion to make use of star catalogues.

The catalogue of stars of the British Association has been advertised recently at 170 mark, or about $43.

STELLAR PARALLAX.

Prof. A. Hall has given in Appendix II to the Washington Observations for 1883 the results of recent observations made with the 26 inch equatorial to determine the parallaxes of α Lyræ, 61 Cygni, 40 (o^2) Eridani, and 6 β Cygni. The results are as follows:

Date.	Star.	Parallax.	No. of observations.
		$''$ $''$	
February 23, 1883, to March 4, 1884	40 (o^2) Eridani	$+0.223 \pm 0.0202$	30
July 31, 1883, to April 15, 1886	6 B Cygni	-0.021 ± 0.0077	54
May 24, 1880, to July 2, 1881	α Lyræ	$+0.134 \pm 0.0055$	128
October 24, 1880, to January 26, 1886	61 Cygni	$+0.270 \pm 0.0101$	101

Dr. W. Schur has published in the Astronomische Nachrichten (vol. 114, p. 161), a discussion of the parallax of the double star ψ^5 Aurigæ from measures of position, angle, and distance made with 6-inch Strassburg refractor, in 1883–'85. The final value for the parallax of the fainter (ninth magnitude) star is $+ 0''.111 \pm 0''.034$. "Herr Schur thinks that he is justified in asserting that the parallax of this star is at least 0″.1—a remarkable result, considering the fixity of the object."

40 (o^2) *Eridani.*—Mr. J. E. Gore, using Professor Hall's parallax, 0″.223, has obtained by means of elements which he has computed, the following figures:

Distance of 40 Eridani from the earth	924,955
Mean distance between the components, B C	26.86
Sum of masses B C Sun's mass = 1	1.003

The unit of distance is the mean distance of the earth from the sun.

DOUBLE STARS.

Two recent papers on personal equation in double-star observations will be found of especial interest to those engaged in this class of work. The first paper forms the subject of a thesis by M. Bigourdan, of the Paris Observatory, submitted for the degree of doctor of physical science. M. Bigourdan reviews the work of others in this field, gives a description of apparatus which he has devised for investigating the problem by means of artificial stars, and deduces his own personal equation from a large number of measures made with this apparatus. He finds that his personal equation is not affected by the position of the eyes with respect to the line joining the stars nor by the altitude; the brightness of the stars, on the other hand, does affect his measures.

The second paper referred to is by Mr. H. C. Wilson, formerly of the Cincinnati Observatory, and is published in the Sidereal Messenger (vol. 5, pp. 174, 211). Mr. Wilson gives an interesting sketch of the history of the subject, together with an investigation of his personal errors, obtained from observations made between 1882 and 1886, with the equatorial of the Cincinnati Observatory. He finds that his measures, both of position angle and of distance, are slightly influenced by the inclination of the head.

Spectroscopic method of determining the distance of a double star.—Mr. A. A. Rambaut, of the Dublin Observatory, in a paper communicated to the Royal Irish Academy on May 24, 1886, discusses at some length the possibility of determining the distance of a double star by measures of the relative velocities of the components in the line of sight. Dr. Huggins having demonstrated that it was practicable to measure the rate of approach or recession of a star, it was seen that it would be at least theoretically possible to determine the distance of a star by this method. Mr. Rambaut's critical examination of the conditions of the problem shows however that the method can have but little practical application.

Orbits of double stars.—The following table gives the "period of revolution" in years, and "semi-axis major," in seconds of arc, obtained for a number of binary stars in recent determinations of elements:

Star.	Period.	Semi-axis major.	Computer.	Published in—
	Years.	$''$		
OΣ 234	63.45	0.339	Gore	Astron. Nachr., 115: 111.
ζ Sagittarii	18.69	0.53	...do	Month. Not., 46: 444.
τ Cygni	53.87	1.19	...do	Astron. Nachr., 115: 215.
40 (o^2) Eridani	139.0	5.99	...do	Month. Not., 46: 291.
β Delphini	30.91	0.517	...do	Proc. Roy. Irish Acad., 2 s., v. 4, No. 5.
γ Coronæ Australis	81.78	1.885	...do	Month. Not., 46: 103.
γ Coronæ Australis	78.80	1.85	Wilson	Sid. Mess., 5: 251.
α Centauri	87.44	18.89	Powell	Month. Not., 46: 289, 336.

VARIABLE, NEW, OR TEMPORARY STARS—COLORED STARS.

Observations of variable stars in 1885.—Professor Pickering prints in the twenty-first volume of the Proceedings of the American Academy his third annual report upon observations of variables, giving particulars of nearly two hundred stars for 1885. The work has been done by co-operation. All who are willing to assist (a field-glass is sufficient instrumental equipment), are requested to send accounts of their work to the Harvard Observatory as soon as possible after the close of each year. Professor Pickering undertakes to make photometric observations of all comparison stars needed.

Mr. Espin, the special observer of the Liverpool Astronomical Society, has commenced the issue of a circular calling attention to various variable stars or stars suspected of variability.

Several interesting cases of variability have been discovered by Messrs. Chandler and Sawyer, of Cambridge. The most interesting case is a new variable of the Algol type discovered by Mr. Chandler in the constellation Cygnus (R. A. $20^h\ 48^m$; Decl. $+ 34° 14'$). The range is from 7.1 magnitude to 7.8 magnitude, the whole variation taking place in about six hours. The only doubt is in regard to the interval during which the star remains at its normal magnitude. Mr. Chandler suspects that the whole duration between two successive periods of change will be found to be about one day, twelve hours.

Gore's new variable near χ^1 Orionis (*Nova Orionis*).—A mass of observations by skillful observers has accumulated, and will repay a thorough study.

It seems to be clearly established that this interesting star is a simple variable, and not one of the class to which the title "temporary" can properly be applied. M. Dunér, who observed the star at intervals from December, 1885, to April, 1886, found (Astron. Nachr., No. 2755), on renewing his observations at the end of October and the beginning of November, 1886, that it had unmistakably increased in brightness in the interval, and was continuing to do so. Herr Fr. Schwab and Mr. Espin confirm this conclusion, the former having observed the star early in last July, and having found it then fainter than the twelfth magnitude. Its period would appear to be not far from one year; Herr Schwab gives it as one or two weeks longer than one year, and as ranging in brightness from the sixth magnitude to 12½, whilst M. Dunér assigns a period of 359.5 days. (Nature.)

According to Dr. Vogel and others who have examined its spectrum, it belongs to Type III a, resembling the spectrum of α Orionis.

The new star in the great nebula of Andromeda.—Professor Seeliger has published (Astron. Nachr., No. 2710) an interesting paper containing an attempt to represent the observed variations of the light of the *Nova* in Andromeda by a formula expressing the rate of cooling of a hot sphere. Supposing that such a body has its temperature suddenly increased to an enormous extent by some shock, its brightness will of course be increased also. And assuming that the latter is proportional to the nth power of the temperature, and using Pogson's scale for transforming brightness into stellar magnitude, Professor Seeliger (making some further more or less probable assumptions) deduces an expression for the magnitude of the cooling star at any time. In order to compare this formula with Herr Müller's photometric measures of the *Nova*, extending from 1885, September 2, to October 13, Professor Seeliger assumes that $n=1$, and that the epoch for which the time $t=0$, is 1885, August 27, 8^h Berlin mean time. Using quite approximate values of the constants involved in his formula, it appears that there is a good general agreement (the mean discordance being 0.11 of a stellar magnitude) between the computed and observed values. The computed magnitude corresponding to the epoch for which $t=0$, is 7.73. The fair agreement shown by this comparison induces Professor Seeliger to think that the form of the expression which he has deduced is such as would accurately represent the observations, provided that it were possible to determine the necessary constants with sufficient precision. And as there is evidence to show that the nebula in Andromeda is, partly at least, composed of a vast number of faint stars, it appears, in Professor Seeliger's opinion, not unreasonable to suppose that a collision was the cause of the sudden development of heat and light which revealed itself to us as the appearance of a "new" star.

With reference to the point thus raised by Professor Seeliger, Herr Auwers points out (Astron. Nachr., No. 2715) that the great similarity of the outburst in Andromeda in 1885 to the phenomenon observed by him in 1860 in the cluster 80 Messier in Scorpio is a strong confirmation of Professor Seeliger's views. The probability that two variable stars of such exceptional character should be projected, in one case on a close star-cluster, in the other case on an object which appears to be, in part at least, a close star-cluster, is so small that it is almost necessary to refer these outbursts to physical changes in the nebulæ in which they respectively appeared. (Observatory, April, 1886.)

Dr. Mills (Nature 33 : 440) in criticising Professor Seeliger's collision hypothesis suggests that the blazing out of the *Nova* may be merely a physico-chemical consequence of cooling; and it has been pointed out by Mr. Castell-Evans (Nature, 33: 486) that practically the same explanation was suggested in 1878 by Prof. R. Meldola in a paper published in the Philosophical Magazine for July of that year. Professor Meldola says: "It is conceivable that in certain cases the composition of a star's atmosphere may be such as to permit a considerable amount of cooling before any combination takes place among its constituents; under such circumstances a sudden catastrophe might mark the period of combination, and a star of feeble light would blaze forth suddenly, as occurred in 1866 to τ Coronæ Borealis. In other cases, again, it is possible that the composition of a star's atmosphere may be of such a nature as to lead to a state of periodically unstable chemical equilibrium; that is to say, during a certain period combination may be going on with the accompanying evolution of heat, till at length dissociation again begins to take place. In this manner the phenomena of many variable stars may perhaps be accounted for."

Dr. von Kövesligethy observing with a 7-inch Merz equatorial at the observatory of Baron Podmaniczky at Kis Kartal, in Hungary, announced the re-appearance of the *Nova* on September 26, 1886. From this date he found that it became more star-like, and up to the evening of October 2 both nucelus and new star were visible. From October 2 to October 17 the old nucleus was invisible. By October 23 the nucleus had assumed its normal state, but the new star was not seen. A number of telescopes were immediately turned upon the nebula, but in the main failed to detect the changes suspected. (*See* Astron. Nachr., 2750–2752.) It is probable that the object seen was one of the very faint points of light known to exist near the nucleus of the nebula.

A very complete series of observations of *Nova* Andromedæ is given by Dr. Copeland, of the Dun Echt Observatory, in the Monthly Notices for December, 1886.

Catalogue of colored stars.—Mr. W. S. Franks has presented to the Royal Astronomical Society a catalogue (not printed, apparently) of 1,730 colored stars situated between the pole and —20° of declination, and including all stars down to the 6.–5 magnitude. The introduction to this catalogue, giving a tabular analysis of the colors recorded, is published in the Monthly Notices for April, 1886.

We should mention also a list of thirty-one prominent colored stars of the southern hemisphere published by Mr. A. S. Williams in the Astronomical Register for October.

Mr. Chambers stated at the meeting of the Royal Astronomical Society on March 12, 1886, that he was preparing a catalogue of red stars.

STELLAR PHOTOMETRY.

Photometric observations at Harvard College Observatory.—Professor Pickering, in his annual report, states that 59,800 separate photometric comparisons were made with the meridian photometer in 1886. The instrument has been found to give entire satisfaction both in the accuracy and the rapidity of its work. Various tests have been applied to detect the presence of systematic errors, but so far with negative results. "A comparison of the seven hundred stars common to the observations of Wolff, Pritchard, and the Harvard Photometry, showed that our results differed on the average from Wolff, after allowance for systematic differences, by 0.140 of a magnitude; from Pritchard by 0.145; while Wolff and Pritchard differed from each other by 0.192. A comparison of the fifty five stars proposed by Professor Pritchard as standards, and measured by him on several nights, showed that the average deviation from the Harvard Photometry was only 0.104. - - - A comparison between the results obtained at Pulkowa and Cambridge shows that the average deviation of a measurement of the difference in brightness between two stars observed at both places does not exceed one-tenth of a magnitude."

The principal work of the meridian photometer, the revision of the Durchmusterung magnitudes, is now approaching completion, nine-tenths of the observations having already been made. During 1887 the observing list will be extended to include stars in the first 20° of south declination.

Observations of the eclipses of Jupiter's satellites, comparison stars for variables, etc., are made with the photometer attached to the 15-inch equatorial.

A comparison of photometric methods.—Mr. S. C. Chandler, jr., presented at the Buffalo meeting of the American Association an important paper on "A comparative estimate of methods and results in stellar photometry," in which he reaches the conclusion (also reached by Dr. G. Müller, of Potsdam,—Vrtljschr. d. astron. Gesellsch., 20 : 261–267), that the photometers now in use give no advantage, in point of accuracy, over direct eye estimates of differences in magnitude made according to Argelander's well known method. With regard to accidental errors, Mr. Chandler concludes that "eye-estimates" are nearly three times as accurate as photometric measures, and he also points out that several variables have been detected and their periods and light-curves well determined by careful eye-estimates, whose whole range of brightness is no greater than the range of error in photometric observations. Reference should be made to Mr. Chandler's paper in the Astronomische Nachrichten, vol. 115, p. 145, merely an abstract of his communication having been published in the Proceedings of the American Association.

A proposed new catalogue of magnitudes of southern stars.—Mr. E. F. Sawyer, of Cambridge, has been at work since 1882 upon a determination of the relative magnitude of the stars included between the equator and 30° of south declination, and not fainter than the seventh magnitude. The observations are made with an opera glass (magnifying two and a half times) put slightly out of focus. The number of stars comprised will approximate 3,500, and the average number of observations for each star will be about three and one-half. Mr. Sawyer finds from 593 stars, each observed twice, that the average difference between two independent determinations of a magnitude of a star is 0.112 of a magnitude, which corresponds to a probable error of a single observation of ±0.065. It is expected that the work will be completed and ready for publication within a year.

STELLAR SPECTRA.

Photographic study of stellar spectra at Harvard College Observatory.—Professor Pickering has announced in his annual report an extensive investigation in stellar spectra, by means of photography, undertaken at the Harvard Observatory. Provision has been made by Mrs. Draper for meeting the expenses of this work, as a memorial to her husband, the late Dr. Henry Draper.

Three researches are now in progress.

The first includes a general survey of stellar spectra. Each spectrum is photographed with an exposure of not less than five minutes, and these photographs generally exhibit the spectra of all stars brighter than the sixth magnitude with sufficient distinctness for measurement. The greater portion of the sky north of −30° has been surveyed in this work, which will be repeated during the coming year. One hundred and fifty-one plates have been measured and 5,431 spectra examined and classified. Of these 4,148 have been identified and the name and position of the corresponding star entered opposite each. The completed work will form a catalogue probably containing three or four thousand stars, each photographed on several plates.

The second research relates to a determination of the spectra of the fainter stars. Each photograph taken in the course of this research receives an exposure of one hour, so that the spectra of all the stars not fainter than the eighth or ninth magnitude, and included in a region ten degrees square, are represented upon the plate. On fifty-eight plates 2,416 spectra have been measured, and of these 2,359 have been identified.

In both of these investigations the 8-inch Bache telescope has been employed.

The third research relates to a more careful study of the spectra of the brightest stars. For this work Mrs. Draper has lent the 11-inch photographic lens employed by her husband. She has also furnished an admirable mounting for the instrument and a small observatory to contain it. Two prisms have been constructed to place in front of the object-glass, the large one having a clear aperture of 11 inches square and an angle of nearly 15°, the other being somewhat smaller. The preliminary results attained with this apparatus are highly promising.

A recent photograph of the region in Cygnus where four stars were known, exhibiting the interesting peculiarity of bright-line spectra, brought out four more spectra of the same kind. One of these is the comparatively bright star P Cygni, in which bright lines, apparently due to hydrogen, are distinctly visible. This phenomenon recalls the circumstances of the outburst of light in the star T Coronæ, especially when the former history of P Cygni is considered. According to Schönfeld, it first attracted attention as an apparently new star in 1600, and fluctuated greatly during the seventeenth century, finally becoming a star of the fifth magnitude, and so continuing to the present time. Another of the stars shown by the photograph to have bright lines is DM. + 37°, 3821, where the lines are unmistakably evident.

ASTRONOMICAL PHOTOGRAPHY.

The improvements in astronomical photography during the past two years, following the introduction of the modern dry plates, have attracted wide-spread attention, and the great merits of the new method scarcely call for any exaggeration in order to establish photography permanently as a means for astronomical research. We find Greenwich, Harvard, Paris, Cape of Good Hope, and Lick taking steps to make stellar photography a part of their routine work, and arrangements have been made by Admiral Mouchez for holding an international conference at Paris in April, 1887, for the purpose of elaborating a plan of co-operation in photographing the whole sky. It is hoped that ten or twelve observatories will be ready to co-operate and that all will be supplied with instruments of the same power, so that the work will form a homogeneous whole. It will require 11,000 plates of 4° each to cover the sky, and ten years will probably be necessary for the completion of the undertaking.

Stellar photography at the Paris Observatory.—An article in Nature (May 13, 1886), which gives a wood-cut of the apparatus used by the Messrs. Henry, gives also the following table of the time of exposure required (with the Monckhoven gelatino-bromide plates) to obtain stars of different degrees of brightness:

Magnitude.		Time of exposure.
1		$0^s.005$
2		0.013
3		0.03
4		0.08
5		0.2
6	The limit of magnitude visible to naked eye	0.5
7		1.3
8		3
9		8
10	Mean magnitude of the asteroids	20
11		50
12		2^m 0
13		5 0
14		13 0
15	The smallest stars visible in large telescopes	1^h 23 0
16		

These figures represent a minimum. To secure good reproductions on paper the time of exposure would have to be increased threefold. A two hours' exposure gives stars much fainter than Herschel's *debilissima*.

The Henrys have successfully photographed the clusters in Hercules, Sobieski, Ophiuchus, and Perseus, and the major planets. They have obtained the trail of an eleventh-magnitude asteroid—a fine line among the stellar points. The new method seems well adapted, also, to the search for a trans-Neptunian planet.

The observatories at Algiers and Rio Janeiro are to be supplied with instruments similar to those at Paris, and an equatorial coudé of 0.6 meter (24 inches) apertue provided with a photographic objective is to be constructed for the Paris Observatory, to test the adaptability of this form of instrument for photographic work.

Stellar photography at Harvard College Observatory.—Professor Pickering's investigations, which were briefly referred to in last year's report, have been published in full in the Memoirs of the American Academy (vol. 11, pp. 179–226). His paper contains a sketch of the history of the subject, description of the apparatus, discussion of theoretical considerations, and some results obtained in the three departments of "star-charting, photographing star trails, and spectrum photography." His work on the photography of stellar spectra we have already alluded to in the present review.

In the report of the Harvard Observatory for 1886 it is stated that the investigation in stellar photography undertaken with the aid of the Bache fund is now nearly completed. The principal results obtained include photographs of the entire sky north of — 30°, on which all stars bright enough to leave trails without the aid of clock-work are depicted. One series of plates exhibits the effect of atmospheric absorption on nearly every night of observation for a year; and among the miscellaneous observations may be mentioned some experiments in the application of photography to transit instruments, which showed that the accidental errors did not reach one-half of those affecting eye-observations. Various photographs were taken of the nebula of Orion to show the relative brightness of different portions of this object. The nebulæ in Andromeda, in Lyra, and in the Pleiades were also photographed. An attempt was made to photograph a satellite of Jupiter while undergoing eclipse, and thus to determine the time of this phenomenon.

Astronomical photography at the Lick Observatory.—In a very interesting article upon astronomical photography, published in the Overland Monthly for November, 1886, Professor Holden thus summarizes the facilities of the California observatory for investigations in this field: "We expect to have a photographic objective as large as 36 inches in aperture, if the glass for this can be obtained. This will be mounted in the most perfect manner, and we shall employ the 12-inch Clark telescope, now at the observatory, as a pointing telescope for the large objective. The 12-inch telescope will be mounted alongside the other. An electrically-controlled driving clock will keep the two telescopes accurately directed during the exposure. Our objective will collect nine times the light of any other photographic telescope now made. - - - The focal length of the combination will be about 580 inches, and 1″ on the plate will therefore be 0.002 inch. This is a quantity whose $\frac{1}{100}$ part can easily be measured. A single exposure will give us a map of the sky comprising four square degrees on a plate 24 by 24 inches. - - - The sun's image unmagnified will be 6 inches in diameter; a large sun-spot will be the size of one's finger-nail. - - - The photographs of the moon in the focus of the Lick equatorial will be 6 inches in diameter, and will probably stand an enlargement of twelve times, so as to be 6 feet finally."

Stellar photography at Cordoba.—Dr. Gould, in a paper read at the Buffalo meeting of the American Association, has described the photographs taken at Cordoba from 1872 to 1882. About seventy southern clusters and more than a hundred double stars were repeatedly photographed. Some sixteen plates of the Pleiades and five of Præsepe were obtained; the total number of photographs being somewhat less than thirteen hundred. Dr. Gould lays great stress on the necessity of promptly converting the photographs into a permanent numerical record: and considerable uneasiness is aroused by the discovery that the collodion or gelatine films are readily detached from the plates. Some progress has already been made in the reductions, under Dr. Gould's immediate supervision at Cambridge.

Pritchard's "Researches in stellar photography."—In a paper with the foregoing title, read at the meeting of the Royal Society, May 27, 1886, Professor Pritchard gives an account of a number of photographs of the Pleiades which he has submitted to a critical examination, with the following objects in view:

(1) To ascertain, by means of definite and accurate measurement, the relation between the diameter of a star-disk impressed on a photographic plate with a given exposure, and its photometric magnitude; a simple formula seems to connect the two. (2) To ascertain whether the photographic plate remains an absolutely accurate picture of the actual relative positions of the stars in the sky itself, and, moreover, whether these are measurable with that extreme degree of precision which is attainable with the best instrumental means. The satisfactory accordances of measures of different plates have afforded a sufficient answer to this inquiry. (3) The third subject of investigation was the relation between the areas of the impressed star-disks and the time of exposure of the plates. As far as at present appears, these areas vary as the square root of the time, though the investigation is not to be regarded as complete. Bond, in 1858, considered that the areas varied directly as the time.

In the course of his work Professor Pritchard noticed what appeared to be a distortion of the photographic film on a small portion of the plate, and he detected a somewhat similar distortion upon one of eight plates of 61 Cygni and neighboring stars. He has hopes that in the course of a year the parallax of certain stars will be re-determined by photography, even to a greater degree of accuracy than has hitherto been achieved by direct instrumental application.

Professor Harkness has suggested that great increase in the accuracy of transit observations of the sun would be gained by inserting a sensitive photographic plate just behind the wire system of the instrument, and making an instantaneous exposure at the time of the sun's transit. This would avoid the disturbance of adjustments of the instrument arising from the exposure to the sun for several minutes, which is necessary in the present mode of observing. Stars would be observed and the instrumental constants determined by using the eye-piece in the usual way.

COMETS.

Professor Bredichin in continuing his researches upon the mathematical theory of comets has re-determined the repulsive forces which produce the tails of different types. Making use of some forty comets in his discussion, he has found for tails of type I, a mean value, $1-\mu=14$; but the comet of 1811, by far the most favorable for the determination of the repulsive force of this type, gave 17.5, and this represents quite well the tails of other comets. In this type the initial velocity g varies from 0.1 to 0.34, the mean being 0.23 (0.1=1.9 miles per second, about). In type II the forces vary from 0.5 to 2.2, and the initial velocities from 0.03 to 0.07, mean 0.05. For the axis of the tail $1-\mu=1.1$. In type III the repulsive forces lie between 0.1 and 0.3, and the velocities between 0.01 and 0.02.

Dr. Holetschek's investigation upon the conditions of visibility of a comet have been followed up by Dr. W. Meyer, who finds that if the great comets of 1843, 1880, and 1882 had reached perihelion in May they would have escaped unobserved. The orbit of the comet seen during the total eclipse of May 16, 1882, must have been very much like that of the comet which appeared four months later (1882 II); it seems, indeed, that the observed position can be represented to half a degree by the elements of the September comet, merely changing the time of perihelion of the latter and fixing it for the 17th of May. The ephemeris computed by Dr. Meyer with these elements shows very plainly why the Sohag comet could not be found after the eclipse, or had not been detected before; it was too faint when in a position favorable for observation. The comet is probably one of a regular stream of comets with small perihelion distance, such as 1843 I, 1880 I, 1882 II. If the orbits of the comets of 1843 and 1880 were sufficiently alike in other respects, the failure in repeated returns would be no objection to their identity, for if the returns have taken place in the month of May, the comet must have been invisible. A revolution in thirty-seven years is hardly to be reconciled, however, with the observations of 1843, and for the great comet of 1882 Frisby has found a period of seven hundred and ninety-four years.

Mr. Monck, in the Observatory for August and September, brings out some interesting statistics in support of his view that there exists a sort of "companionship" among comets—that is, cases in which the elements show a striking similarity; but it is improbable that the bodies are identical. Several of the comets of short period exhibit a family likeness which can hardly be attributed to their capture by Jupiter unless they previously formed members of a system. The question derives further interest from its bearing upon meteoric showers, for, if a family of comets can be supposed to be accompanied by a family of meteors, a shower from nearly the same point might continue for a considerable time, giving rise to stationary radiants to which Mr. Denning has called attention.

It may not be out of place here to point out the value of physical observations of cometary phenomena—accurate observations of jets, tails, brightness, etc.—which may furnish data for testing any theories of their origin and constitution that may be put forward.

Encke's comet.—The progress of investigations upon Encke's comet may be briefly stated thus: The comet which has now been observed at twenty-four apparitions since its first discovery in 1786 "was shown by Encke to be subject to a remarkable decrease in the length of its period, a decrease which could not be accounted for by the attractive force of the sun and planets. Encke surmised that this was produced by the effects of a resisting medium. His calculations, which extended up to 1848, were continued by von Asten, who in a great measure confirmed Encke's conclusions, but found the curious anomaly that between the apparitions of 1865 and 1871, the acceleration of the mean motion which had been exhibited until the former of these years ceased to appear. Since the death of von Asten the work has been continued by Dr. Backlund, who has succeeded in showing that the apparent anomaly in question was due to an error in the formulæ of perturbations employed, and vanished when this was corrected. He was led however to the remarkable and interesting result that the acceleration of the mean motion of the comet is subject to a progressive diminution, and amounted between 1871 and 1885 to scarcely one-half of what it was between 1819 and 1865." It was reduced from 0''.104 to 0''.062. It seems very probable that about the year 1868 the acceleration underwent a change, due no doubt to some unknown modification in the physical condition of the comet.

Dr. Backlund has recently resumed his labors, which were interrupted by illness, and the first memoir, relating to the return in 1885, has just been printed; the second, treating of the comet's motion since 1865, will soon be presented to the St. Petersburg Academy of Sciences; while the third, which is in preparation, will comprise the period 1819–1868. For these researches the author has been awarded the Lalande prize of the Paris Academy.

Comet Tempel-Swift.—Bossert has given in the Bulletin astronomique an elaborate discussion of the orbit of the comet discovered by Tempel in 1869, but not recognized as periodic till its rediscovery by Swift in 1880. The period is about five and one-half years, but the comet escaped notice in 1875 and again in 1886.

Comet 1873 VII.—M. Schulhof has published (Bull. astron., 3:125 *et seq.*) a discussion of the orbit of this comet, and has gone into the question of its possible identity with 1818 I and 1457 I (the observations of which by Toscanelli have recently been discussed by Professor Celoria).

His conclusion, expressed with some reserve, is that 1873 VII and 1818 I are distinct bodies, with a short period of revolution but having a common origin. *Comet* 1457 I is probably identical with 1873 VII, but it is also possible that the two comets 1873 VII and 1818 I are fragments of 1457 I.

Comet 1877 VI.—Dr. Larssén, of Upsala, has completed the definitive determination of parabolic elements of the comet discovered by Coggia at Marseilles on September 14, 1877, and observed to December 10 of that year. The observations have been newly reduced and combined in five normal places, with a very satisfactory result. (Astron. Nachr. 116 : 23–26.)

Comet 1881 V.—The close agreement of the elements with those of the orbit of a comet discovered by Blanpain on the 28th of November, 1819, has led to a conjecture that the two comets are identical, although Blanpain's was computed to have a period of less than five years and Denning's of nearly nine, it being supposed that planetary perturbation had lengthened the period between the appearance of 1819 and that of 1881. It has been noticed both by Mr. Plummer and by Mr. Denning that the longitude of the ascending node of the 1881 comet corresponds almost exactly with that of the descending node of Biela's comet, which has not been seen as a comet (or rather double comet) since 1852, though it has been supposed to be connected with a very brilliant meteoric display seen on the 27th of November, 1872. The other elements of Denning's comet exhibit a remarkable agreement with those of Biela's comet; and the suggestion in question is that these comets are identical, or rather that Denning's is identical with the principal remaining portion of Biela's, which underwent violent perturbation through near approach to the earth in 1872, sufficient to lengthen its period and reverse the nodes (a necessary consequence of altering the inclination through zero). Colonel Tupman, whose calculations well confirm this theory, remarks "that on the 27th of November, 1872, it is probable that the comet was very near the earth and mixed up with the meteoric shower." The comet passed its perihelion on the 13th of September, 1881; the computed length of its period was 8.83 years, or about 3,225 days; and this was almost exactly the interval which had elapsed since the meteoric display of the 27th of November, 1872. If this theory be true, we can not expect another similarly brilliant display on that day until the year 1916, five periods of the comet's revolution in its orbit being very nearly equal to forty-four of the earth's. (Athenæum.)

Comet 1881 VIII.—Olsson finds a period of 612 years; that found by Oppenheim was 2,740 years, though Oppenheim remarks that 900 years would satisfy the observations almost as well.

Comet 1882 II.—The valuable series of observations of this comet made at the Cape of Good Hope, including the remarkable observation of the disappearance of the comet at the limb of the sun, has been published as vol. II, part 1, of the Annals of the Cape Observatory. Interesting observations of the tail, accompanied by numerous sketches, are found in vol. I of the Publications of the McCormick Observatory, the observers being Messrs. Leavenworth and Jones.

Comets of 1886.—Nine comets passed perihelion in 1886; three of them visible to the naked eye. One was a well-known periodic comet returning at the appointed time, and two of the new-comers appear to be periodic, one of them identical possibly with De Vico's lost comet of 1844. Olbers's comet of 1815 was not detected, but as an uncertainty of some three years exists in the period of revolution, it may be picked up during the coming year. The Tempel-Swift comet due at perihelion on May 9 seems to have escaped notice on account of its excessive faintness. Of these nine comets, three belong to Barnard, three to Brooks, two were found by Finlay, and one by Fabry; two were discovered in 1885, one in 1887; leaving six discovered in 1886. Comet 1886 IX was picked up by three observers independently, on three successive mornings in October, showing what a careful watch is kept by comet-hunters. Warner prizes to the amount of $800 were paid for the captures.

Comet 1886 I:
=Comet *d* 1885.
=Fabry's comet.

This comet, as noted in last year's report, was discovered on December 1, 1885, at Paris. From a faint little patch of nebulosity it grew steadily in size and brightness, and on March 29, 1886, Fabry described it as having a diffused nucleus about 15″ in diameter, comparable with a star of the seventh magnitude; a tail about 20′ long and 4′ broad, was thrust out in a position angle of 325°, while the nebulosity extended about 1′.5 beyond the head. It became rapidly more prominent, and on April 3 was visible without difficulty to the naked eye. On April 23 the head was as bright as a third-magnitude star, and the tail 4° long. The greatest length of the tail was probably about 9°, but the comet was not a very conspicuous object on account of its slight elevation above the horizon before sunrise, and also on account of the moon-light. It is said to have remained visible to the naked eye from the early part of April to beyond the middle of May. Observations were continued in the southern hemisphere until about the end of July.

The determination of the orbit presented some difficulties, and the elements from early observations were not entirely accordant. Dr. S. Oppenheim's elements (Astron. Nachr., 2722), derived from observations extending to March 28, placed perihelion passage on April 5, 1886; the nearest point to the earth and greatest brilliancy (about four hundred and seventy-five times as bright as when discovered) were reached about May 1.

The spectrum was studied by Trépied, Perrotin, Rayet, Vogel, and others. The three bands common to comets and hydrocarbons were found—the central band, perhaps, somewhat intensified; and besides these bands there was also a continuous spectrum.

Dr. Müller, of Potsdam, has published in the Nachrichten (No. 2733) a very interesting series of photometric observations of this comet and of the comet discovered by Barnard on December 3, 1885. The observations extended over the months of March and April, 1886; and both comets were increasing in brightness. Reducing the measures to a distance unity, the intrinsic brilliancy seems to have been tolerably constant; from which it may be concluded that the comets shone almost entirely with borrowed light. This conclusion is confirmed by Dr. Müller's spectroscopic observations, according to which the continuous spectrum predominates. Trépied, on the other hand, found that in Fabry's comet the proportion of reflected sunlight was small, gaseous elements predominating and the bands being much brighter than the continuous spectrum. Dr. Müller remarks that his observations show no effect of phase, and he suggests that this may be due to a variation in the inherent light of the comet as it approaches the sun and earth, or we may assume that the nucleus is made up of discrete particles by which the phase phenomena must to a great extent be modified.

Comet 1886 II:
=Comet *e* 1885.
=Barnard's comet.

A brief account of this comet was given last year, as it was discovered by Barnard on December 3, 1885, with a 6-inch Cooke equatorial. A small tail about 15′ long was detected by Tempel as early as December 31. In April and May the comet developed into quite a fine object with stellar nucleus and fan-shaped tail, 2° or 3° in length. It was seen with the naked eye on May 7 and 12 by Mr. Barnard, at Nashville, and on May 31 and June 3 by Mr. Tebbutt, at Windsor, New South Wales. The last observation published was made on July 19, at Cordoba. A careful series of "extinction observations" is given by Dr. Holetschek in the Nachrichten, No. 2739. The spectroscope showed the three ordinary cometary bands, with faint, continuous spectrum of the nucleus.

The latest elements computed by Thraen from observations between December 5, 1885, and May 10, 1886, place perihelion passage on May 3, and give a slightly hyperbolic orbit (eccentricity=1.0004). Whether the curve really differs from a parabola can not be decided until all the observations, including those from southern observatories, can be taken into account. Morrison has obtained hyperbolic elements agreeing tolerably well with those of Thraen. Earlier elements showed a slight resemblance to comet 1785 II, but it is not probable that the comets are identical.

Comet 1886 III:
=Comet *b* 1886.
=Comet 1886 .... (Brooks 2).

This was discovered by Mr. W. R. Brooks, at Phelps, New York, on April 30, 1886, or in civil reckoning on the morning of May 1; his second comet within four days. Mr. Brooks described it as having a small but bright and star-like head, and a conspicuous tail. On May 4 there was a tail 10′ or 12′ long; very bright near the origin. Engelhardt, on May 6, found the tail 40′ long and nearly straight, while 8′ from the nucleus there was a faint secondary tail bending towards the south. Pechüle, observing from May 3 to May 12, detected two nuclei or condensations in the head. Barnard says it was a most singular looking telescopic comet—"a perfect miniature of the naked-eye appearance of a great comet." It does not seem to have been observed beyond the last week of May, when its theoretical brightness was about half that at the time of discovery.

According to Wendell's elements the comet passed perihelion on May 5. Dr. Weiss called attention to the fact that at the ascending node the orbit approached quite near the orbit of the earth, so that when the earth passed the line of nodes, July 9, a meteoric shower visible in the southern hemisphere might result from particles following in the wake of the comet. We believe, however, that no unusual display was reported.

Comet 1886 IV:
= Comet *c* 1886.
= Comet 1886....(Brooks 3).

Discovered on the evening of May 22, 1886, by W. R. Brooks, in the constellation Virgo, a large, nearly round, and feebly luminous spot with a slight condensation occasionally visible. It was decreasing in brightness when detected, and passed out of sight early in July. Mr. Sherman, of the Yale Observatory, found the three cometary bands in its spectrum. Dr. S. Oppenheim has calculated an elliptic orbit with a period of about nine years. Dr. Hind makes the period very much shorter, not much more, in fact, than six and a quarter years, according to which the comet would return in the autumn of 1892. The perihelion passage took place on June 6 or 7. A new discussion of the orbit has been undertaken by Drs. Oppenheim and Bidschof, of Vienna.

Comet 1886 V:
= Comet *a* 1886.
= Comet 1886....(Brooks 1).

Discovered by Brooks on the evening of April 27, the first comet found in 1886. Until May 3 or 4 it was a round nebulous object 1′ or 2′ in diameter. An uncertain nucleus could occasionally be made out. On May 5 and 9 several bright points were seen in the nucleus, giving it a "granular" appearance. On May 18 the nucleus was of the eighth magnitude, and May 21 and 25, sixth to seventh magnitude with nearly circular coma 2′ 20″ in diameter. Dr. Krueger's elements show that the comet's nearest approach to the sun, 0.27 (the radius of the earth's orbit being unity), occurred on June 7.

Comet 1886 VI:
= Comet *d* 1886.
= Winnecke's comet.

Winnecke's periodic comet (five and two-thirds years) for which an ephemeris had been prepared by Dr. Lamp, was detected by Mr. Finlay, of the Cape of Good Hope Observatory, on August 19. During its two or three weeks of visibility it was a faint, misty object, 1′ or 2′ in diameter, without tail, but with some central condensation. Perihelion was passed on August 19, about twelve days earlier than predicted by Dr. A. Palisa. An attempt was made at Paris to photograph the comet, but without success.

Comet 1886 VII:
= Comet *e* 1886.
= Finlay's comet.

Discovered by Mr. W. H. Finlay, of the Cape of Good Hope Observatory, on September 26, 1886, and reported as "faint, circular, about 1′

in diameter, with some central condensation, and no tail." The possible identity with "De Vico's lost comet," 1844 I, (for which Brünnow found a period of 5.5 years), immediately attracted attention, and elliptic elements have been calculated by Boss, Krueger, Oppenheim, and Holetschek. The computation of the orbit presents some difficulties, and it is impossible to settle the question of identity until all observations at this return have received a thorough discussion—if it can be settled then. The last set of elements obtained by Professor Boss (Astron. Journ., v. 3, p. 43) place perihelion passage on November 22, 1886, and give an approximate period of 6.675 years. With this period the comet, if undisturbed, should return to the sun in July, 1893, under conditions quite favorable for observation. It is still visible, nearly five months after discovery.

Comet 1886 VIII:
= Comet *c* 1887.
= Barnard's comet.

A faint, telescopic comet was found by Barnard at Nashville on January 23, 1887 (the morning of January 24 in civil reckoning), which proved to have passed perihelion on November 25, 1886, and it therefore takes a place preceding the comet discovered by Barnard on October 4. As it was receding from the earth and the sun, it rapidly grew fainter. Perihelion distance obtained by Weiss was 1.4 times the mean distance of the earth from the sun.

Comet 1886 IX:
= Comet *f* 1886.
= Comet 1886 *f* (Barnard, October 4).
= Comet 1886.... (Barnard-Hartwig).

This comet was discovered by E. E. Barnard, at Nashville, Tenn., on October 4, 1886 (or morning of October 5). It was also discovered independently by Dr. E. Hartwig at the Bamberg Observatory on October 5, and by Dr. C. F. Pechüle, at Copenhagen, on October 6. It was an easy object in the telescope, and developed a tail early in October. By October 29 the nucleus was as bright as a star of the eighth magnitude, and the comet was visible to the naked eye as an ill-defined spot. Two distinct tails were detected about this time, and Barnard found a third on November 23. The comet was now easily seen with the naked eye, as conspicuous as a star of the fourth magnitude, with a slender train traceable for 7° or 8°. The tail seems to have reached a maximum length of about 10° during the first week of December, the theoretical brightness of the comet being then about twenty-five times that at discovery.

Riccò, of Palermo, found the spectrum composed of the three hydrocarbon bands, of which the middle one (green) was longest and brightest. The spectrum of the nucleus was continuous, but re-enforced at the bright bands.

Elements computed by Lieutenant Allen from observations reaching to December 10 show that perihelion was passed on December 16, 1886. No deviation from a parabola is indicated.

METEORS AND THE ZODIACAL LIGHT.

The Biela meteors of November 27, 1885.—Professor Newton has collected all the published data in regard to this great shower, and has submitted it to a thorough discussion in an article of nearly twenty pages of the American Journal of Science for June, 1886.

We quote merely his summary statement of conclusions:

"1. The maximum of the shower was near 6^h 15^m Greenwich mean time.

"2. Three hours after the maximum the number of meteors had diminished to one-tenth the maximum number, and it is not unreasonable to assume six hours as containing the principal part of the shower.

"3. The total hourly number of meteors visible at one place in a very clear sky to some one or other of a very large group of observers may at maximum be regarded as 75,000.

"4. In the densest part of the meteor stream, where and when the earth encountered it, the space that corresponded to each meteoroid was equal to a cube whose edge was about 20 English miles.

"5. The dense part of the stream was not over 100,000 miles in thickness.

"6. The *zenithal attraction* of the Biela meteors was about one-tenth of the observed zenith distance of the radiant.

"7. The radiant was an area several degrees across.

"8. It is reasonable to suppose that the meteoroids, while in the upper part of the atmosphere, before the paths become luminous, change direction by a glancing due to irregularity of form. After the resistance has developed heat enough to melt or burn off projecting angles of the stones, and the tracks become luminous, the forms of the bodies become rounded in front and the paths described are straight lines.

"9. The meteoroids encountered by the earth on the 27th of November, in 1872 and in 1885, did not leave the immediate neighborhood of the Biela comet earlier than 1841–'45, and may be treated as having at that time orbits osculating that of the comet. The determination of the paths of these meteoroids through their five and seven last revolutions about the sun seems to be a problem capable of complete solution."

Professor Newton's presidential address at the Buffalo meeting of the American Association, on "Meteorites, meteors, and shooting stars," has been published in Science (8 : 169–76), and in Nature (34 : 532–36).

M. P. F. Denza reports that a careful watch maintained on the night of November 27, 1886, at seven observatories on the Italian peninsula, showed no repetition of the great shower of 1885. This would indicate that the stream is of small extent but very dense, and would tend to strengthen the hypothesis that it originated in the recent disintegration of Biela's comet.

Herr Förster finds for the radiant points of the great meteor showers of 1872 and 1885:

1872	R. A. 23°.3	Decl. + 43°.3.
1885	23°.5	+ 43°.3.

A recent bulletin of the New England Meteorological Society gives a discussion, by Professor Newton, of a meteor seen on September 6, 1886, height, time and place of appearance and disappearance, etc. It is desired that observers should report the position of bright meteors, noting their paths among the stars, and trails, if any, with as much accuracy and detail as possible.

Mr. Denning publishes in the Monthly Notices for November some interesting results he has obtained from the study of a catalogue of more than 82,000 meteors from 3,035 radiants. Mr. Denning himself contributes to his catalogue no less than 7,000 meteors. He also, in another place, calls attention to the marked agreement between the orbit of Halley's comet and a pronounced meteor shower with radiant close to η Aquarii. The maximum shower occurs about May 6. This radiant needs further observation.

Relation of the zodiacal light to Jupiter.—Dr. Geelmuyden, speaking of Professor Searle's researches upon the zodiacal light, says: "If the zodiacal matter has the same position among meteoric matter in general as comets of short period among comets, it is to be expected that the fundamental plane of the zodiacal light will have some relation to Jupiter as the principal motor in deflecting the orbits, and therefore in collecting the matter. Now it is worth remarking that the most northerly point of Jupiter's orbit has the heliocentric longitude 188°, or with 60° east elongation 178° geocentric longitude; and for matter in the same plane, but nearer the sun, the approximation to coincidence with 160° is still greater."

THE SUN.

Motion of the solar system in space.—Several attempts have lately been made to obtain the direction and rate of motion of the solar system in space. These results are discordant among themselves, and, as the investigators have remarked, are not entitled to very great weight, on account of the meagerness of the data available, but it may not be without interest to give the values obtained.

Herr Homann, from a discussion of the spectroscopic observations made at Greenwich, and from the observations of Huggin and Seabroke, finds:

	Velocity of translation, in miles per second.	Apex of solar motion.	
		R. A.	Decl.
Greenwich	24.4 ± 2.7	320°.1	+41°.2
Huggins	30.1 ± 14.3	309 .5	+69 .7
Seabroke	15.2 ± 9.8	278 .8	+13 .6

There is only a rough sort of agreement, but all three unite in placing the apex considerably in advance, in right ascension, of the apex as found from the proper motions of stars by Struve, Airy, Dunkin, and others (the mean position generally assigned is, R. A. 260°; Decl. +35°), while Struve found a velocity of translation of only about 4½ miles per second.

Herr Homann is inclined to think that the velocity of translation of the sun does not differ very much from the velocity of the earth in its orbit, that is, 18½ miles per second. Dr. von Kövesligethy in 1883 found from spectroscopic observations that the rate of motion of the solar system was 8.6 geographical miles per second. The spectroscopic observations were insufficient to determine the direction, and he assumed the apex in R. A. 216°.0, Decl. +35°.1.

Dr. Ubaghs, of Liège, in making a preliminary examination of the aberration due to the motion of the solar system, pointed out by M. Folie, has obstained a result which would give a velocity of only about 180 feet per second.

The velocity of light and the solar parallax.—Professor Newcomb has published in vol. 2 of the "Astronomical papers prepared for the use of the American Ephemeris" the details of his researches on the velocity of light, made during the summer months of 1880, 1881, and 1882. The apparatus used, to which the name "photo-tachometer" has been given, is a modified form of Foucault's revolving mirror. The result obtained for the velocity of light *in vacuo* is 299,860 kilometers, or 186,327 miles per second, with a probable error of 30 kilometers. Michelson found in 1879 a velocity of 299,910 kilometers, and repeating his work at Cleveland in 1882, he obtained 299,853. Accepting the value 299,860 as the true one, it becomes of interest to consider the value thereby deducible for the parallax and distance of the sun. The latest and probably the most accurate determination of the constant of aberration is that of Dr. Nyrén, 20″.492. Combining this with the above velocity of light and Clarke's value of the earth's equatorial radius (6,378.2 kilometers), we obtain 8″.794 for the value of the solar parallax, almost exactly the same as that obtained from heliometer observations of Mars in 1877. The corresponding distance of the sun is 92,960,000 miles.

With regard to a possible difference between the velocities of rays of different colors, it is pointed out that the phenomena of variable stars seem to be conclusive against the hypothesis of any such difference. Were there a difference of one hour in the times of the blue and the red rays reaching us from Algol, this star would show a well-marked coloration in its phases of increase and decrease. No such effect, however, has been noticed. Recent researches by Professors Michelson and Morley have led to a similar result.

Transits of Venus 1874 *and* 1882.—The work of the United States Transit of Venus Commission is being rapidly carried to completion under the immediate supervision of Prof. William Harkness. The reductions of observations made at the various stations for time, latitude and longitude are finished, the determination of longitudes having required a thorough examination of all the great chains of telegraphic longitude. A volume containing all of the observations for 1874—all of the 1874 work except the discussion of the photographs—is now in press.

Dr. Auwers reports, under date of January 11, 1886, that the reductions of the German heliometer measures are well advanced and that the printing has been begun; and M. Bouquet de la Grye announces for the French commission that the photographic plates, 1,019 in number, have been measured, and that the reductions are now half done, and will be finished about the end of 1887.

Theory of sun-spots.—Professor Young, in an article on "Recent advances in solar astronomy," makes the following comments upon an important paper by M. Belopolsky, of the Moscow Observatory. published in the Astronomische Nachrichten, No. 2722:

"Some recent investigations upon the rotation of fluid masses, by Jukowsky, of Moscow, as applied to solar conditions by his colleague Belopolsky, seem to warrant a hope that the phenomena of surface-drift in longitude, and even the periodicity of the spots, may soon find a rational explanation as necessary results of the slow contraction of a non-homogeneous and mainly gaseous globe. The subject is difficult and obscure; but if it can be proved, as seems likely, that on mechanical principles, the time of rotation of the central portions of such a whirling mass must be shorter than that of the exterior, then there will be of necessity an interchange of matter between the inside and outside of the sphere, a slow *surface*-drift from equator toward the poles, a more rapid *internal* current along and near the axis from the poles toward the equator, a continual 'boiling up' of internal matter on each side of the equator, and, finally, just such an eastward drift near the equator as is actually observed. Moreover, the form of the mass, and the intensity of the drift and consequent 'boiling-up' from underneath might and probably would be subject to great periodic variations.

"This theory falls in well with the facts established by Spoerer respecting the motion of the sun-spot zones, and the general though slow poleward movement of sun-spots."

Sun-spot observations at Kalocsa.—A summary (Astron. Nachr., 116: 31) of sun-spot observations at Kalocsa, 1880–1885, shows the predominance of spots in the southern hemisphere of the sun over those in the northern hemisphere, particularly well marked, since the beginning of 1883. A similar result is shown in the Greenwich observations, and has also been pointed out by Dr. Spoerer; on the other hand, from 1880 to 1883 the northern hemisphere had the greater number of spots. It has been noticed, furthermore, that since 1880 the spots show a tendency towards the equatorial zones.

Observation of sun-spot spectra.—Professor Young mentions a somewhat curious observation of sun-spot spectra, which he has recently made. He finds that under high dispersion the spectrum of the darkest part of the spot is not continuous, but is made up of countless fine, dark lines, for the most part touching or slightly overlapping, but leaving here and there unoccupied intervals which look like (and may be) bright lines. "It seems to indicate that the principal absorption which darkens the center of the sun-spot is not such as would be caused by minute solid or liquid particles—by smoke or cloud, which would give a continuous spectrum; but it is a true gaseous absorption, producing a veritable dark-line spectrum, in which the lines are countless and contiguous."

Solar activity in 1886.—According to Professor Tacchini's observations (Comptes Rendus, 103:120; 104:216), it appears that there was a decided falling off in the number and size of sun-spots during the year 1886. In March, however, there was a considerable temporary increase; and on the 8th of May a magnificent group of spots was visible in the sun's northern latitude. A well-marked minimum occurred in November, and rather peculiar "secondary minima" seem to have fallen in the months of February, May, and August. Prominences also showed a diminution in number and size compared with those seen in 1885, but the fluctuations were much fewer than in the case of the spots. A particularly remarkable eruption was observed on March 9 and 10.

Professor Tacchini places the last great minimum of spots in March, 1879, and the last maximum in February, 1884; if then the decrease in the number of spots during the latter part of 1886 corresponds to a new minimum, we shall have an interval from the last maximum of only 2.8 years, whereas the mean interval is seven years. So short an interval between maximum and minimum is very exceptional, for the shortest known since 1750 is 4.3 years; the longest is ten years.

Total eclipse of the sun, August 28–29, 1886.—A party consisting of Lockyer, Tacchini, Schuster, Maunder, Perry, and others, was sent out by the British Government to the island of Grenada, in the West Indies, to observe the total eclipse of August 28–29, 1886. A full review of the results of the expedition can not be given until the detailed report is ready. Preliminary accounts show that only one division of the party, that with Mr. Lockyer at Green Island, failed entirely on account of clouds, though the observations at some of the other stations were more or less interfered with. Photometric observations and photographs of the corona and of its spectrum were obtained, and also good spectra of the prominences, showing the bright lines of highly incandescent vapors. In this respect the result resembles that obtained in the two previous eclipses, though it was thought possible that this year, being one when sun-spots were tending to a minimum, would be marked by the more continuous spectrum that bespeaks lower temperature.

Prof. W. H. Pickering, of Boston, observing from Fort Green, obtained a number of photographs and some interesting photometric observations. He also organized a series of observations of the shadow bands.

Observations of the partial phase were made at the Azores, Martinique, Port au Prince, and at several points along the eastern coast of the United States. No parties were sent out by the United States Government.

Photography of the solar corona.—Dr. Huggins's method of photographing the corona in full sunshine seems to have failed when submitted to a crucial test in the eclipse of last August. In a letter to Science, dated September 11, 1886, Dr. Huggins says: "The partial phases of this eclipse furnished conditions which would put the success of the method beyond doubt if the plates showed the corona cut off partially by the moon during its approach to and passage over the sun. As the telegrams received from Grenada, and a telegram I have received this day from Dr. Gill, at the Cape of Good Hope, state this partial cutting off of the corona by the moon is not shown upon the plates, I wish to be the first to make known this untoward result. I regret greatly that a method which seemed to promise so much new knowledge of the corona, which, under ordinary circumstances of observation, shows itself only during total eclipses, would seem to have failed. At the same time I am not able to offer any sufficient explanation of the early favorable results."

Mr. Common thinks it probable that this failure to get a picture of the moon projected on the corona was due entirely to the state of the sky; and Professor Langley, in a recent letter to Nature (35: 53), adds his testimony as to the great effect of atmospheric diffusion upon the visibility of the corona. Moreover, Dr. Huggins says that he has not himself been able to obtain any satisfactory results since 1883, and that the plates taken by Mr. Ray Woods in 1884, in Switzerland, are inconclusive. The failure may be due to the abnormally large amount of air-glare from finely divided matter of some sort which has been present in the higher regions of the atmosphere since the autumn of 1883.

It is interesting to note that Professor Wright, of New Haven, in experimenting upon the visibility of the corona, succeeded in obtaining what he believed to be a coronal image upon a screen, when he, too, was brought to a standstill by these same "white skies" and "red sunsets." Professor Wright's method was to admit the sun's rays reflected from a heliostat, into a darkened room, and to cut out all but the blue and violet rays by a suitable absorbing cell, and then to form an image of the sun and its surroundings upon a sensitive fluorescent screen, stopping out the sun's disk itself.

Professor Young seems to have some slight hope of ultimate success of these efforts to reach the corona without an eclipse.

Langley's observations of hitherto unrecognized wave-lengths.—Professor Langley having traced the solar spectrum in the infra-red as far as wave-length =0.0027 of a millimeter, where it suddenly ceased, has since, with more delicate instruments, examined the emission spectra of various terrestrial substances at temperatures from that of fusing platinum to that of melting ice, and more particularly of temperatures corresponding to the ordinary conditions of the soil. The result has been to show that the maximum of heat from cold and black bodies has in every case a wave-length greater than 0.0027—greater, that is to say, than that of the lowest solar heat which reaches us. Professor Langley thus sums up (Am. J. Sc., 132: 84–106) his investigation: "Broadly speaking, we have learned through the present measures with certainty of wave-lengths greater than 0.005 millimeter, and have grounds for estimating that we have recognized radiations whose wave-length exceeds 0.03 millimeter, so that while we have directly measured to nearly eight times the wave-length known to Newton, we have probable indication of wave-lengths far greater, and the gulf between the shortest vibration of sound and the longest known vibration of the æther is now in some measure bridged over."

The visual solar spectrum in 1884.—Professor Piazzi Smyth made a careful map of the solar spectrum in 1884 in order to determine whether any perceptible effect had been produced by the "white skies" so prevalent in that year. His observations have lately been published in a series of sixty plates, in the Transactions of the Royal Society of Edinburgh, vol. 32. He finds that the red and violet ends of the spectrum show a marked general dulling, such as should arise from the upper air being laden with minute opaque particles—whether from the Krakatoa explosion or any other source.

Thollon's map of the solar spectrum.—M. Thollon, in the Bulletin astronomique for July, gives some interesting details in regard to the great map of the spectrum for which the Lalande prize of the Paris Academy was awarded him about a year ago. An earlier map from A to H was finished by Thollon in 1879, but he determined to go over the work again with improved instruments, and to make a chart representing, with all the accuracy attainable, the positions, breadths, and relative intensities of the lines, a chart which will enable us to determine in the future whether any changes have taken place. For even now, from the comparison of M. Thollon's chart with that of Ångström, there is a strong suspicion that some change has occurred in the intensity of several lines between B and C.

M. Thollon has carried the map from A to *b*, and it is to be continued to the violet by M. Trépied. It is now more than 33 feet long (though it covers little more than one-third of the spectrum), and contains about 3,200 lines, nearly 900 of which are distinguished as of telluric origin. The instrument employed was a large spectroscope with bisulphide of carbon prism, kept at an even temperature by running water. The measures were made with a fine glass pointer.

Cornu's device for distinguishing the telluric lines in the solar spectrum.—At the meeting of the Royal Astronomical Society, on June 11, 1886, M. Cornu gave a description of an ingenious method he has devised for distinguishing between those lines of the solar spectrum which are atmospheric and those which are due to solar absorption. The east and west equatorial limbs of the sun are alternately thrown on the slit of the spectroscope by means of an oscillating mirror. As one limb of the sun is approaching us and the other receding, there is a real difference of wave-length in the same radiation as obtained from the two limbs, and consequently the solar lines appear to oscillate while the atmospheric lines remain perfectly stationary. "It is as if you shook the spectrum; and if a line were a solar one it moved, if a terrestrial one it remained steady."

The absorption spectrum of oxygen.—About three years ago M. Egoroff was able to show that the great groups A and B in the solar spectrum were due to the absorption of oxygen. More recently the α band was also found to be due to the same gas. M. Janssen, studying the absorption of oxygen, has now discovered that, under certain conditions, the gas yields another spectrum, composed no longer of lines easily separated, but of shaded bands, which can only be resolved with great difficulty. This system of bands appears for moderate pressures much later than the spectrum of lines, but it shows itself very quickly with increase of the density; the two systems are so different that it is possible to obtain either the first without the second, or *vice versa*. M. Janssen was at first unable to explain how it was that these bands were not visible in the solar spectrum when they were easily obtained by passing light through thicknesses of oxygen far less than the sun's light has to traverse before reaching us. But further experiments showed that these bands did not develop in proportion to the thickness of the stratum of oxygen producing them, multiplied by its density, but in proportion to the thickness multiplied by the square of the density. The density of our atmosphere being small as compared with some of the pressures at which M. Janssen worked, the non-appearance of these bands amongst the telluric lines of the solar spectrum is readily explained.

M. Janssen is continuing his experiments at Meudon, and is building tubes which can be loaded with 1,000 atmospheres of hydrogen, oxygen, or carbonic acid. In this last case the real density of the gas will be superior to the density of water. (Nature.)

For a thorough and authoritative review of recent advances in our knowledge of the sun the reader should consult Professor Young's article which appeared in the Popular Science Monthly for November, 1886 (30:24–33), and also his "Ten Years' Progress in Astronomy," in vol. 5 of the Transactions of the New York Academy of Sciences.

THE PLANETS.

MERCURY: *The mass of Mercury.*—Dr. Backlund has published in the Bulletin astronomique for October a new mass of Mercury, obtained incidentally in his discussion of the motion of Encke's comet. The new result in question is $\frac{1}{2668700}$, the sun's mass being unity, and this is the largest value of the mass of the planet yet obtained. Dr. Backlund states that, even supposing the acceleration of the comet's mean motion to have been constant during the entire period, 1871–'85, it is not possible to represent satisfactorily the five apparitions of the comet during that period on the assumption of a mass of Mercury less than $\frac{1}{3000000}$.

VENUS: *Semi-diameter of Venus.*—Mr. Thackeray, discussing the observations of Venus made at Greenwich from 1866 to 1884, finds that the amount of personality in the measures is much greater than the correction due to the instrument, and that, though a greater number of observers by compensating one another might give increased accuracy to the value of the semi-diameter, it is just as likely that they should not.

THE EARTH: *Geodetic Congress.*—We learn from Nature that the International Geodetic Conference met at Berlin in October, 1886, to settle the organization of the central geodetic bureau (which is to have its permanent seat at Berlin), and to determine upon the best method of executing the resolutions passed at Rome and Washington in 1883 and 1884, respecting the actual measurement of a degree on the earth's surface. The adoption of Greenwich as a first meridian is to be strictly enforced, but the introduction of international normal time is postponed on account of insuperable practical difficulties.

The proposed change in the beginning of the astronomical day.—It is to be regretted that no agreement has yet been reached by astronomers upon the proposition to change the beginning of the astronomical day from noon to midnight.

The general sentiment is opposed to making any change until it is clear that it will be adopted by a majority of astronomers, and until the proper modifications have been introduced into our principal ephemerides. The new day has been provisionally adopted by Mr. Christie, at Greenwich, and the board of visitors have recommended that it be introduced into the Nautical Almanac for 1891. On the other hand, the superintendents of the German and American ephemerides oppose any change; and there seems to be great danger that the agitation of the question by the Washington Meridian Conference in 1884 may introduce new confusion rather than remove the old. At present there is little prospect of the plan meeting with anything like a general acceptance before the beginning of the next century.

Theory of the moon's motion.—Several valuable papers upon the lunar theory have been published by Hill and others. Reference should be made to the papers themselves, cited in our Bibliography.

Mr. Hill has received the gold medal of the Royal Astronomical Society for his laborious and masterly researches upon this difficult subject.

An interesting historical note on the inequalities of the motion of the moon which depends on the figure of the earth, is given by Professor Hall in the Annals of Mathematics, vol. 2, No. 5.

MARS: *The "canals" of Mars.*—M. Perrotin and his colleagues at Nice succeeded in recovering many of Schiaparelli's enigmatical "canals" at the last opposition of Mars, although the planet was seen under very unfavorable conditions. Its apparent diameter at this opposition was only 14″, against 25″ at the opposition of 1877, when the canals were discovered. The canals were made out by several observers at Nice, and were recognized as having the same general outline and position attributed to them by Schiaparelli in 1882. They seem, therefore, to be essentially permanent, forming a sort of network of grayish lines projected against the brighter equatorial regions of the planet. Compared with the thickness of the spider lines of the micrometer, the finest of these lines appear to have a width which corresponds to an arc of 2° or 3° on the surface of Mars. Some of them measure from 50° to 60° in length, and several are double, composed of lines strictly parallel, separated, according to Schiaparelli's estimate, by intervals of from 6° to 12°. All of this speaks well for the purity of the atmosphere at Nice, the excellence of the 15-inch Henry refractor, and the keenness of the observers.

During the study of the planet (fróm the end of March to the middle of June) some change seemed to be taking place near Kaiser Sea. On May 21 this region, from 10° to 55° north latitude, was hidden by a luminous veil somewhat softer in color than the continents, very much as if clouds in regular parallel bands were stretched across the planet from northeast to southwest. At moments these clouds became transparent, exposing the outline of the prolongation of Kaiser Sea. Other similar cloud phenomena were observed on subsequent days. M. Perrotin suggests that these phenomena were really produced by clouds or mists circulating in the atmosphere of Mars, and concludes that they are, in such case, the act of an element belonging to the atmosphere, or to the surface of the planet, susceptible of motion and modification in a comparatively short time.

Mr. Denning, who has been an attentive observer of Mars, has not been able to make out the canals in the detail assigned to them by Schiaparelli, although he has distinguished a large number of appearances highly suggestive of these configurations. Mr. Denning concludes a review of his recent observations of the planet (Nature, 34: 105) as follows:

"Many of our leading treatises on astronomy attribute a dense atmosphere to Mars, but nothing has been observed during my recent observations to corroborate this theory. It seems to me far more plausible to assume that the atmosphere of this planet is extremely attenuated. The chief spots are invariably visible, and the phenomena occasionally observed are rather to be imputed to the vagaries of our own atmosphere than to that of Mars.

"Jupiter and Saturn are doubtless enveloped in dense vapors shrouding their real surfaces from terrestrial eyes. Their markings are atmospheric, though in some cases very durable, and constantly undergoing changes of aspect and displacements of position by longitudinal currents. On Mars a totally different nature of things prevails. Here the appearances described are absolute surface markings displaying none of the variations which are so conspicuously displayed on Jupiter. - - - It seems to me that the very pronounced character of the markings and their great permanency are quite opposed to the idea that the planet is surrounded by a dense cloud-laden atmosphere."

Dr. Lohse has used, in observing Mars, a double-refracting prism, achromatized for the extraordinary ray; this prism, placed before the ocular of the telescope, brings out more sharply the details of the planet's surface by reducing the polarized light reflected from its atmosphere.

Satellites of Mars.—Professor Hall was able to observe the outer satellite, Deimos, on four evenings in March, 1886, but the inner satellite was seen only once, and was then so faint that no measurements could be made. Both little bodies were near their predicted places.

THE MINOR PLANETS.—Eleven minor planets were added to the list in 1886, the last one bearing the number 264; the brightest was of the eleventh magnitude. Seven of the new-comers belong to Dr. Palisa, making the total number discovered by him fifty-seven. Dr. Peters has now discovered forty-six and Dr. Luther twenty-three.

The dates of discovery and the names, as far as assigned, are given in the following table:

Minor planets discovered in 1886.

No.	Names.	Date of discovery.	Magnitude at discovery.	Discoverer.	Observatory.
254	Augusta	March 31, 1886.	13.5	J. Palisa	Vienna.
255	Oppavia	....do	13.5	....do	Do.
256	Walpurga	April 3	12.5	....do	Do.
257	Silesia	April 5	13	....do	Do.
258	Tyche	May 4	11.3	R. Luther	Düsseldorf.
259	Aletheia	June 28	12	C. H. F. Peters	Clinton.
260	Huberta	October 3	13.5	J. Palisa	Vienna.
261	Prymno	October 31	11.2	C. H. F. Peters	Clinton.
262	Valda	November 3	12	J. Palisa	Vienna.
263	Dresda	....do	12	....do	Do.
264	Libussa	December 22	11.5	C. H. F. Peters	Clinton.

Number 253, discovered by Dr. Palisa on November 15, 1885, has been named *Mathilde.*

The influence of phase on the brightness of the minor planets.—Dr. G. Müller, of the Potsdam Observatory, is led to believe from observations of seven asteroids with a Zöllner photometer, that there is a real connection between the phase of these bodies and their apparent brightness, and that Lambert's law of phase brightness does not apply to them. The planets are separated into two classes. In the first class, class, which embraces Vesta, Iris, Massilia, and Amphitrite, the changes in brightness are only perceptible as the planet approaches opposition, thus resembling Mars in their behavior; in the second, which contains Ceres, Pallas, and Irene, the changes in brightness seem to be coextensive with the changes of phase, giving a light curve, like that of the the moon or Mercury.

The asteroid ring.—M. A. Svedstrup gives in the Nachrichten, Nos. 2740–41, an interesting abstract of a recent investigation, for which he received the gold medal of the Royal Danish Academy—a statistical examination of the orbits of 198 of the small planets, considered as part of a cosmical ring around the sun. The orbit obtained for the "mean planet" shows an inclination of about 6° and a mean distance of 2.64. The mass of this fictitious planet corresponds to an apparent magnitude, at opposition, of 6.7.[*]

Relation of the asteroid orbits to that of Jupiter.—Professor Newton points out the interesting fact that the plane of Jupiter's orbit coincides almost exactly with the mean plane of the orbits found for the first 251 asteroids, understanding by the mean plane, the plane whose pole is the center of gravity of the poles of the asteroid planes; the difference between the poles is, indeed, only 30′.

JUPITER: *The "red spot."*—The "great red spot," some 30,000 miles in length by 8,300 in width, has now been the principal object of interest on the planet for eight years. It was faint during the last season, but far more conspicuous than in 1885. Professor Young obtained, from eight observations made between March 17 and June 29, 1886, a rotation-time of the spot of $9^h\ 55^m\ 40^s.7 \pm 0^s.2$, showing that the remarkable retardation of the period still persists. This is brought out by the following figures:

In 1879	Mr. Pratt made the period....	$9^h\ 55^m\ 34^s.9$
1880–'81	Mr. Hough made the period...	37.2
1882–'83	Mr. Hough made the period...	38.4
1883–'84	Mr. Hough made the period...	38.5
1884–'85	Mr. Hough made the period...	40.1
1886	Mr. Young made the period...	40.7

Professor Young, on re-reducing Mr. Pratt's observations of 1879, obtains $9^h\ 55^m\ 34^s.05$, and he finds from a series of observations made by Prof. C. W. Pritchett, in 1882, $9^h\ 55^m\ 38^s.15$. A small round white spot observed at Princeton in March and April, 1885, gave a period of 9 55^m $11^s.14$. "It is noteworthy that although this spot was in a higher latitude (about 50° south) than the red spot, it yet rotates more rapidly." Professor Young remarked the apparent overlapping of the southern belt and the red spot which took place towards the end of March and the beginning of April, and which was seen by many English observers (Observatory, May, 1886, vol. 9: p. 188); but whilst admitting that it was impossible to say which was uppermost, he was inclined, in opposition to Mr. Denning's view, to believe the red spot to be the lower. Mr. Denning has pointed out that the apparent partial coalescence of the two markings was simply due to an arm of the southern belt overtaking the red spot, the former having a rotation period shorter by about 19^s than the latter.

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[*] In the Bull. astron., 3: 415, this is corrected to 6.0 magnitude.

Mr. Denning finds evidence of regular recurrence in many of the prominent markings on this planet.

SATURN: *The satellites of Saturn.*—Professor Hall has finished a very important discussion of the six inner satellites of Saturn, and his work has been published as Appendix I to the Washington Observations for 1883. The observations of Professor Newcomb in 1874, and Professor Hall's own observations from 1875 to 1884, are given in detail; these are followed by the formation of equations of condition and their solution, and the work concludes with useful tables of the satellites' motions.

A remarkable result of the discussion is that the Washington observations of the five inner satellites can be satisfied within the limits of their probable errors by circular orbits. It was hoped that the observations would determine the positions of the lines of apsides with such accuracy that the motions of these lines would be known, and that thus we might obtain data for a new determination of the mass of the ring and of the figure of the plant. But the resulting circular orbits for the inner satellites make the position of a line of apsides indeterminate, and for the present the mass of the ring remains unknown.

The mass of Saturn has been computed from the elements found for Titan, Rhea, Dione, and Tethys with the separate results for the reciprocal of the mass, —

From Titan	3480.07 ± 1.138
Rhea	3450.43 ± 6.202
Dione	3463.68 ± 8.379
Tethys	3463.41 ± 10.629

or, the mean result from the four satellites, is

$$\text{Mass of Saturn} = \frac{1}{3478.7 \pm 1.10}$$

the mass of the sun being unity.

In a paper in the Astronomische Nachrichten (No. 2743) entitled "Comparison of the five inner satellites of Saturn made at Toulouse in

1876 and 1877," Professor Hall discusses the old method of observing these difficult objects by noting their conjunctions with the ends of the ring, or with some other marked feature of the Saturnian system, but concludes that the filar micrometer measures are at present among the best we have. He is inclined to think that the heliometer, if it can be made large enough, must be one of the best instruments for dealing with measurements of such objects as Saturn and Jupiter. This suggestion is being carried out by Mr. Asaph Hall, jr., in a series of observations of Titan with the 6-inch heliometer of the Yale College Observatory.

The following table represents the results of Professor Hall's investigations upon these satellites. The elements of Titan, however, and the values of the node and inclination of the ring are adopted from Bessel. Mimas, Enceladus, Tethys, Dione, and Rhea are assumed to move in the plane of the ring, and Hyperion in the plane of Titan.

Elements of the satellites of Saturn, 1880.

Satellite.	Mean daily motion.	Time of revolution.	Mean distance from Saturn.
	°	d	"
Mimas	381. 99078572	0. 9424311	26. 80
Enceladus	262. 73177276	1. 37021875	34. 40
Tethys	190. 69838434	1. 88779785	42. 734
			"
Dione	131. 53500629	2. 7369140	54. 734 ± 0. 0442
Rhea	79. 69010973	4. 5174991	76. 537 ± 0. 0459
Titan	22. 57700000	15. 9454245	176. 915 ± 0. 0193
Hyperion	16. 919883	21. 276742	213. 98
Iapetus	4. 53794773	79. 3310152	515. 5195 ± 0. 02645

Satellite.	Longitude of Peri-Saturnium.	Eccentricity.	Inclination to ecliptic.	Longitude of node.
			° ′ ″	° ′ ″
Mimas	Circular	Zero	28 10 16. 7	167 55 5. 9
Enceladus	do	do	28 10 16. 7	167 55 5. 9
Tethys	do	do	28 10 16. 7	167 55 5. 9
Dione	do	do	28 10 16. 7	167 55 5. 9
Rhea	do	do	28 10 16. 7	167 55 5. 9
	° ′ ″			
Titan	268 37 56. 0	0. 02841836	27 33 56. 7	168 10 34. 8
Hyperion	83 37 55. 2	0. 1	27 33 56. 7	108 10 34. 8
Iapetus	353 14 56. 5	0. 027795	18 33 39. 5	142 26 41. 4

The motion of Hyperion.—Tisserand in investigating the case of two satellites moving around their primary in orbits but little inclined to each other has shown that if the mean motions are very nearly commensurable, and if the motion of one was originally circular and uniform, the perturbations caused by the other would have for their principal effect to transform this motion into motion in a Keplerian ellipse with a uniform rotation of the major axis. Applying this to the case of Hyperion perturbed by Titan, which has been investigated by Hall and Newcomb, and in which there is one of the nearest approaches to commensurability of mean motions to be found in the solar system, M.

Tisserand finds that his results agree closely with the facts of observation, the computed rate of retrograde motion of the perisaturnium of Hyperion being 18°.8 per annum, whilst the observed quantity is 20°, and he also finds that his value of the mass of Titan ($\frac{1}{10780}$) differs little from that obtained by Newcomb. (Observatory, November, 1886, 9:360.)

Uranus.—Observations of the planet made by Dr. H. C. Wilson at the Cincinnati Observatory in 1883 (recently published in Astron. Nachr., 2730), seem to confirm Professor Young's observations (Astron. Nachr., 2545), that the equator of the planet does not coincide with the plane of the satellites' orbits.

Neptune: *Satellite of Neptune.*—Marth calls attention (Month. Not., 46: 507) to what appears to be a remarkable change in the position of the plane of the orbit of Neptune's satellite. He noticed that the orbit from the Malta observations of 1863–'64 did not agree with that from the observations of 1852. The node and inclination obtained by Newcomb in 1874 showed a movement in the same direction, and the motion of these elements is still further confirmed by the orbit recently published by Professor Hall from his own observations at Washington. The probable errors are so small that it seems hardly plausible or possible to attribute the change to systematic errors of observations. Mr. Marth calls for careful observations to strengthen the evidence.

REPORTS OF OBSERVATORIES.

The following account of the recent activity of astronomical observatories is compiled from all available sources, the "Vierteljahrsschrift" furnishing, as usual, the data for most of the observatories, although the latest reports there published are for the year 1885. I am indebted to the directors of many observatories for the direct communication of information in regard to the institutions under their control.

An alphabetical list of astronomical observatories, compiled by Mr. Boehmer, will be found in the Smithsonian Report for 1885.

M. Lancaster, of the Bruxelles Observatory, has published a useful directory of observatories and astronomers.

Algiers Observatory (1886).—The French Government has granted the funds necessary for the completion of the observatory, and two assistants have been sent to join M. Trépied. A time service has been organized for the cities of Algiers and Tunis, and the observatory will cooperate in geodetic work with field parties. Stellar photography will receive special attention. The observatory possesses a spectroscope by Thollon giving a spectrum 10 meters in length.

Allegheny Observatory (1886).—The work during 1886 has consisted of an extension of former researches on invisible radiations, and on the absorption and radiation of heat by the earth's atmosphere, and also of researches upon the absolute temperature of the lunar surface. In connection with this latter investigation a new field of exploration has been opened in spectral regions, where the planet's own radiations towards space, of very great wave-lengths—exceeding one one-hundredth of a millimeter—are now for the first time found.

Professor Langley, in giving a portion of his time to the Smithsonian Institution, has not resigned the active directorship of the observatory, and all communications relative to the scientific or business affairs of that institution should be addressed to him at Allegheny as usual. Mr. F. W. Very continues at the observatory as senior assistant. Mr. Keeler is now at the Lick Observatory, and has been succeeded at Allegheny by Mr. James Page, jr.

Amherst (1885).—This observatory, named in honor of the Hon. Abbot Lawrence, was built in 1847, and has been employed chiefly for purposes of instruction. Professor Todd was appointed director in July, 1881, and his report covers the years 1881-1885, inclusive. The instruments of the observatory are: A 7¼ inch Clark equatorial, a 3-inch Gambey transit circle, and a 6⅜-inch Pistor & Martins transit instrument, with mean-time and sidereal clocks, chronograph, and subsidiary apparatus. The equatorial is provided with two small cameras for celestial photography. Observations are made of sun-spots, of the phenomena of Jupiter's satellites, occultations of stars by the moon, etc. The provisionally adopted position of the observatory is: Latitude, $+42^\circ\ 22'\ 17''.1$; longitude, $4^h\ 50^m\ 4^s.67$ west of Greenwich.

Ann Arbor (1886).—The observatory is known as the Detroit Observatory, having been founded through the liberality of citizens of Detroit. Valuable additions and improvements have been made by means of further contributions from the same source and from the city of Ann Arbor, and also by appropriations made by the board of regents of the University of Michigan, to which the observatory is attached. The building consists of a main part, with a movable dome, and two wings. The east wing contains the large meridian circle by Pistor & Martins and a sidereal clock by Tiede, of Berlin. The west wing contains the library of the observatory, a chronograph with Bond's new isodynamic escapement, and the smaller instruments. This wing connects with the residence of the director. In the dome is mounted a large refracting telescope, with an object-glass 13 inches in diameter, constructed by the late Henry Fitz, of New York.

Much attention is given to instruction in astronomy, and through the liberality of the legislature a small observatory for the purpose of instruction has been erected on the observatory grounds near the main building. It contains an equatorial telescope of 6 inches aperture and a transit instrument of 3 inches aperture, with zenith telescope attachment. A building near by contains computing rooms and rooms for observers, and a workshop where necessary repairs and attachments for the instruments can be made. A set of self-registering meteorological instruments has recently been added. It consists of Hough's barograph and thermograph and an anemograph.

The observatory is under the direction of Prof. M. W. Harrington, who is assisted by Mr. J. M. Schaeberle and a meteorological observer. Professor Harrington has devoted considerable time during the past few years to photometric observations, especially of the asteroids. Mr. Schaeberle has made observations with the meridian circle.

The observatory plant is valued at about $40,000, and the annual expenditures amount to about $3,000. It should be mentioned that the American Meteorological Journal is edited here by Professor Harrington.

Armagh (1886).—Under the direction of Dr. Dreyer the Armagh catalogue of 3,300 stars has been published.

Bamberg (1886).—This observatory, founded by the will of the late Dr. Remeis, of Bamberg, who died in 1882, will be provided with a 7-inch heliometer, the largest instrument of its kind made. Dr. Hartwig proposes to take up the systematic investigation of stellar parallax, and the investigation of the physical libration of the moon.

Berlin (1885).—With the meridian circle, Dr. Küstner has observed a series of comparison stars for planets and comets, stars which have been occulted by the moon, stars for heliometer investigations, etc. There have been made in all 2,096 observations of right ascension and 1,936 of declination; the reductions are up to date. A new observing list, containing the Pulkowa "Zusatzsterne" and Argelander's proper motion stars—about 1,000 objects in all—was started in 1886. The transit has been used for observations of circumpolars, and also for continuing the observations upon seven selected pairs of stars, which are to furnish data for determining the constant of aberration. With the 9-inch refractor Dr. Knorre has observed a large number of comets and planets, and with the aid of his "declinograph" he has determined the positions of about a thousand stars, some as faint as the thirteenth magnitude. Dr. Battermann observed occultations with the 4.6-inch refractor. The investigations upon the movements of piers have given interesting results, and the clock which has been for four years in a hermetically sealed case, continues to perform most satisfactorily.

Bonn (1885).—The meridian circle was devoted, mainly, to continuing the Gesellschaft zone observations. Volume VIII, the Southern Durchmusterung, was published during 1886, and the printing of the twenty-four charts which are to accompany this work has been begun. The reduction of the zone work is not quite finished. The director, Dr. Schönfeld, has been assisted in observing by Drs. Scheiner, Deichmüller, and W. Luther. Dr. Scheiner was absent a considerable portion of the year, serving a term of military duty.

Breslau (1885).—The observatory, under the charge of the veteran Dr. Galle, is engaged in meteorological and magnetic work. Assistant, Dr. Lachmann.

Buchtel College Observatory (1886).—Professor Howe has devoted his time to instruction in practical astronomy. The cost of the observatory was about $5,000.

Bucknell University Observatory.—Mr. William Bucknell has given the sum of $10,000 for an observatory at Lewisburgh, Pa. A 10-inch equatorial has been ordered from Clark and a 3-inch transit from Ertel. The building is of brick, 25 feet by 150 feet, a dome 16½ feet in diameter surmounting the central tower.

The observatory, under the direction of Prof. W. C. Bartol, is to be used for instruction in practical astronomy, and will be ready in June, 1887.

Chabot Observatory (1886).—This new observatory, the gift of Anthony Chabot, esq., to the city of Oakland, Cal., is under the direction of Mr. F. M. Campbell. The instruments are, an 8-inch equatorial, with micrometer and spectroscope, a 4⅛-inch transit, chronograph, clocks, etc. The geographical position given (Sid. Mess., 5:286) is: Latitude, $+37^\circ\ 48'\ 5''$; longitude, $3^h\ 0^m\ 54^s.3$ west of Washington.

Cincinnati (1886).—The Cincinnati Observatory was founded in 1842 by an astronomical society, and was afterward transferred to the University of Cincinnati, of which it now forms one of the departments. A new building was erected in 1870 upon Mount Lookout, about 4 miles east and 2 miles north of the central portion of the city. The observatory grounds comprise 4 acres on the summit of the hill. The building is of brick; it consists of a central portion supporting the dome, and two wings, the western being furnished with meridian shutters, and the eastern containing the library.

The observatory possesses the Mitchel refractor of 11 inches aperture, made by Merz & Mahler, and supplied with a filar micrometer and a double-ring micrometer. The magnifying powers range from 90 to 1,500. There is also a portable equatorial of 4 inches aperture by Clark, with magnifying powers ranging from 15 to 250. The transit instrument, by Buff & Berger, has an aperture of 3 inches and is furnished with a latitude level and an eye-piece micrometer for measuring differences of declination. The total value of the instruments is estimated to be about $12,000. The library contains over fifteen hundred bound volumes besides a large number of pamphlets.

The financial support is derived from a city tax, the yearly income from which is about $5,000. This provides for the salary of the director, one assistant, and a janitor, the payment of the ordinary expenses, and the publication of results. The purpose of the observatory is both educational and scientific. Instruction in astronomy is given in connection with the university, and the observatory is also open to the public for the first hour of each evening.

The principal work of the past year (1886) has been the prosecution of the zone observations with the 3-inch transit instrument. In these zones about 4,000 stars between the declinations -19° and -22° have been observed, most of them three times or more. The work of preparing this catalogue for publication is already commenced, and in the progress of the work Professor Porter has detected a number of interesting cases of proper motion. The catalogue will probably be issued during the coming year. A few observations of nebulæ, double stars, and comets were also made during the early part of the year, but were suspended owing to the resignation of Mr. H. C. Wilson, assistant astronomer.

The work proposed for 1887 is the completion of the observations required for the zone catalogue, and after that the continuation of a series of charts of southern nebulæ.

Cointe (1886).—The new observatory attached to the University of Liège, Belgium, is under the direction of M. Folie, the director of the Brussels Observatory. The instruments are a 10-inch equatorial and 6-inch meridian circle (diameter of circle about 31.5 inches), both by Cooke, with numerous smaller astronomical and geodetic instruments, and a set of magnetical and meteorological instruments. M. Folie is assisted by Dr. L. de Ball and M. P. Ubaghs.

Columbia College Observatory (1886).—The observatory is upon the top of the college library building, 100 feet above the level of Forty-ninth street, New York City. The 13-inch Rutherford equatorial, 3-inch transit, and zenith telescope are mounted in a room about 24 by 30 feet. The instruments rest upon solid piers of masonry, which are supported by heavy iron girders, the floors and ceilings nowhere touching the girders. The instrumental equipment embraces also a 5-inch equatorial (not mounted at present), a Troughton & Simms transit, spectroscope and subsidiary apparatus, clock, chronometers, portable transit, personal-equation machine, etc. The dome is by Waters & Son, of Troy, New York, and consists of a paper covering with wooden ribs. The shutters of the transit slits are also paper, and open by the action of springs.

Some trouble is caused by vibrations from the railroad trains (over one hundred a day) constantly passing within 100 feet of the building, but at times the instruments are very steady.

A careful redetermination of the geographical position of the observatory will be made, as the old longitude seems to be somewhat in error. It is also hoped to devote the Rutherford equatorial, which is supplied with a photographic corrector, to astronomical photography.

Professor Rees, the director, has but one assistant, and the greater part of his time is required to carry on a very complete course of instruction in practical astronomy, designed especially for training engineering students.

Dearborn Observatory (1886).—The Dearborn Observatory is the property of the Chicago Astronomical Society, but is upon ground leased to it by the now extinct University of Chicago, and may at any time be required to vacate. A new site has not yet been selected. Observations of Jupiter and of double stars have been made with the equatorial during 1886, and the necessary observations for furnishing time to the city of Chicago have been made with the meridian circle. A catalogue of two hundred and nine new double stars has been sent to the Nachrichten. It is expected that observations of double stars, Jupiter, and the satellites of Uranus will be kept up during the coming year. The instruments of the observatory are valued at $30,000. There is no permanent endowment, and Professor Hough carries on his work without assistants.

Deutz (1885).—Herr Emil Mengering established in 1884 a private observatory, the principal instrument being a 5-inch refractor by Reinfelder & Hertel. Physical observations of the moon and Jupiter have been made, and attention is being directed to astronomical photography and spectroscopy. Approximate geographical position: Latitude, $+50^\circ\ 56'\ 33''$; longitude, $+0^h\ 25^m\ 45^s.0$ west of Berlin.

Dresden (1885).—At Baron von Engelhardt's observatory observations were made of comets, nebulæ, double stars, the phenomena of Jupiter's satellites, occultations by the moon, etc.

Dresden (1885)—Dr. Drechsler, of the "Mathematischer Salon," continues a series of meteorological observations begun in 1828.

Düsseldorf (1885).—Since 1847, 1,271 observations of 157 asteroids have been made.

Frankfort-on-the-Main (1885).—Herr Epstein continues his star-gauges and his observations of sun-spots.

Geneva (1885).—Four hundred and ninety-eight chronometers were tested during 1885, some of them showing an uncommon degree of excellence. Forty-two chronometers were entered on December 1, 1885, for a twelve-weeks' special trial of temperature compensation. M. Kammermann has employed the 10-inch equatorial in observations of comets, nebulæ, and satellites. Meteorological observations are continued as in former years.

Gotha (1885).—Dr. Becker has given up the greater part of his time to the reduction of his zone observations. The equatorial which has received a new 4½-inch objective by Reinfelder & Hertel, and has been thoroughly repaired, was remounted in October. A series of observations was made with the meridian instrument.

Greenwich (1886).—The annual report of the astronomer royal, Mr. Christie, was submitted to the board of visitors of the Greenwich Observatory on June 5, and gives an account of the progress and activity of the observatory for the year ending May 20, 1886. The regular work of the transit circle and the altazimuth has been continued, and very satisfactory results have been obtained with the apparatus for determining absolute personal equations brought into use with the former instrument some months ago. Spectroscopic observations include a considerable number made of the new star which burst out in the great nebula of Andromeda. The spectroscopic observations of Sirius indicate, as in the last three years, a displacement of the F line towards the blue; this displacement would correspond to a motion of the earth towards Sirius at a rate of something more than 20 miles per second, though, from the nature of the observations, the amount of such a motion can not be considered as very accurately determined. For the year 1885 a photographic record of the sun's surface can be made out for three hundred and sixty days by filling up the gaps in the series of Greenwich photographs from photographs obtained in India and the Mauritius. Observations of comets and of casual phenomena have been made with the equatorials; and the magnetic and meteorological observations, the time-service, etc., have been kept up as in previous years. The full import of the statement that the reductions of the observations are keeping pace with their registration will be appreciated by all who are engaged in routine astronomical work.

In regard to the new equatorial Mr. Christie says: "The construction of an object-glass of 28 inches aperture and 28 feet focal length, with suitable tube, to be mounted on the southeast equatorial, has been authorized by the Government, and the necessary funds have been provided in the estimates. The work has been intrusted to Mr. Grubb, with whom I have arranged the details of the tube, which is to be of special construction, adapted to the conditions of the mounting, and available for spectroscopy and photography as well as for eye observations. Mr. Grubb proposes to provide means for readily separating the lenses of the object glass to such a distance as will give the proper correction for photographic rays."

It is proposed to refit the 12¾-inch refractor for astronomical photography by placing a combination of a convex flint and a concave crown lens about 2 feet within the focus, in order to correct the chromatic aberration of the objective for the photographic rays without alteration of the focal length.

Grignon (1885).—Observations of sun-spots and of the physical appearance of planets, etc.

Hamburg (1885).—Only one hundred and nineteen nights in the year were favorable for observing. Besides the meridian observations and the observations of planets and comets, a large number of chronometers have been tested. Dr. Schrader has left the observatory to take part in a scientific exploring expedition, and his place is filled temporarily by Dr. Wilhelm Luther. The time balls at Cuxhaven and Bremerhaven have worked satisfactorily, the former having failed only four times and the latter five. The Hamburg ball has given more trouble, having failed, from various causes, twenty-one times during the year.

Harvard College Observatory (1886).—The forty-first annual report of the director covers the year ending November 1, 1886. About half the Paine bequest, or $164,198, has become available for the support of the observatory; and the funds, which in 1875 amounted to $164,067 and in 1885 to $226,988, have now risen to $398,046. This increase must for the present be devoted to the publication of observations already made, and to effecting repairs in the buildings and instruments. A new mounting for the 15-inch equatorial is required, and Professor Pickering expresses the hope that at no distant day means may be found for replacing the present building by one better adapted to the requirements of modern astronomy.

The most important extension of the work of the observatory which has recently been made is in the field of stellar photography. With the aid from the Bache fund almost the entire visible sky has been photographed, and a large number of photographs of stellar spectra have been obtained. For continuing the researches upon a stellar spectra Mrs. Draper has lent the 11-inch photographic lens employed by her husband, the late Dr. Henry Draper, and has provided means for a new mounting at Cambridge, and for the proper reduction and publication of the results. This investigation has been referred to under "Astronomical photography."

The 15-inch equatorial has been used for photometric observations, observations of new comets, and of the new stars in Andromeda and Orion, and for experiments in photography.

The work projected for the meridian circle is now completed, and the reductions are being pushed as rapidly as possible. Volume XV, part I, containing the annual results for the fundamental stars, 1870–'79, and the individual results, 1883–'86, has been published; it includes also the results from the separate observations of stars belonging to various special classes, and the catalogue of 1,213 stars, separately issued in 1885. The second part of this volume will contain the catalogue of zone stars. Volume XVI (published) contains a tabular statement of the instrumental constants and a journal of the observations. A volume corresponding to volume XVI, but relating to the zone stars instead of the fundamental stars, and another, containing the observations for absolute right ascension and declination made from 1879 to 1883, will complete the work of the meridian circle still requiring publication. The resignation of Prof. William A. Rogers, who has had charge of this instrument since it was mounted in 1870, is greatly to be regretted. Professor Rogers has accepted the position of professor of astronomy at Colby University, Waterville, Maine, but will, however, superintend the reduction of his meridian observations and their publication.

The meridian photometer, Professor Pickering states, has given entire satisfaction, both in accuracy and in rapidity of work. (*See* Photometry.) A time-ball is dropped at the Boston post-office, and the telegraphic announcement of important discoveries has been continued under the management of Mr. Ritchie. The report concludes with a list, embracing twenty-two titles, of contributions to astronomical literature made by officers of the institution during the year.

The following financial statistics, some of which may be found in further detail in the report of the treasurer of the university, will be of interest:

Value of grounds, Harvard Observatory	$80,000
Value of buildings	25,000
Value of instruments	40,000
Endowment	398,000
Total	543,000

The available annual income, including gifts for immediate use, is $22,000. The salary of the director is $3,400, the use of the house being estimated at $600 more. The sale of time signals brought in nearly $3,000 during the year. The principal items of expenditure are—

Total expenditure for salaries, including that of director	$12,000
Total expenditure for instruments	800
Total expenditure for publications	3,500
Repairs and improvements on buildings and grounds	940

The personnel includes Professor Pickering, the director; assistant, Prof. W. A. Rogers (resigned September 1, 1886); assistant, Prof. A. Searle; and Messrs. Wendell, Edmands, Ritchie, Gerrish, Gifford, and Metcalf; with six computers, ladies.

The Boyden fund, which was left for the purpose of astronomical research "at such an elevation as to be free, so far as practicable, from the impediments to accurate observations which occur in the observatories now existing, owing to atmospheric influences," has been transferred to Harvard College and will be administered at the observatory. The fund at present exceeds $230,000. Professor Pickering proposes to establish an experimental observing station in Colorado, but desires to occupy ultimately some high mountain peak in the southern hemisphere where observations—largely photographic, probably—can be carried on in co-operation with Cambridge. Information in regard to eligible sites south of the equator is much desired.

Heidelberg (1886).—Private observatory of Dr. Wolf. The principal instrument is a 6-inch equatorial; objective by Reinfelder & Hertel, mounting by Sendtner, of Munich. A photograph of the observatory is given in Sirius, vol. 19, Heft 12.

Helsingfors (1885).—Dr. Donner has continued to observe the moon, moon-culminating stars, and planets, with the large transit instrument. This instrument is to be remodeled by Repsold into a meridian circle. A portable transit of 6.9^{cm} (2.7 inches) aperture by Repsold has been mounted in the prime vertical. The equatorial has been used for observing comets.

Herény (1885).—The mirror of the 10¼-inch reflector having been resilvered by Professor Safarik, the instrument has been arranged for experiments in celestial photography. Herr von Gothard has succeeded in photographing several constellations, star-clusters, nebulæ, and stellar spectra, but the work is still regarded as experimental. Spectroscopic observations and drawings of the planets have been continued as heretofore.

Hillsborough, Ohio.—Private observatory of Henry A. Pavey. Approximate position: Latitude, $+39° 12'$; longitude, $5^h 34^m$ west of Greenwich. The instruments are a 4-inch equatorial by Benjamin Pike's Sons, with mean-time clock and chronometer, and other accessories. Physical observations of the sun and Jupiter have been made, and observations of the zodiacal light. Variable stars have been observed in accordance with the plan proposed by Professor Pickering.

Kalocsa Observatory (1886).—Dr. C. Braun has published a report of the observatory founded by Cardinal Haynald, archbishop of Kalocsa. The instruments are a refractor, by Merz, of 7 inches; another of 4 inches; a transit, by Cooke, of 2.3 inches; altazimuth, clocks, spectroscopes, photometers, etc. The latitude from geodetic observations is $+46° 31' 41''.92$; astronomical methods give it $0''.07$ greater. The longitude is $1^h 15^m 54^s.343$ east of Greenwich. A valuable series of sun-spot observations has been made and discussed.

Karlsruhe (1886).—The observatory at Karlsruhe (Baden) is still in a small, temporary, wooden building, the instruments having been removed in 1881 from Mannheim to the present quarters in Karlsruhe, where the observatory forms a part of the "Techniche Hochschule." Unfortunately the financial condition of the Grand Duchy of Baden has thus far precluded the establishment of a thoroughly equipped observatory, which has been in contemplation. The temporary building has two small meridian rooms, and a dome. The instruments are: (1) a 6 inch refractor by Steinheil, lately remounted by Fecker & Co., of Wetzlar; (2) an old repeating circle by Reichenbach some years ago changed into a meridian circle by Hildebrandt & Schramm, of Freiberg; the telescope has an aperture of 84 millimeters (3.3 inches); the divided circle is 3 feet in diameter; (3) a large portable transit instrument by Bamberg, of Berlin; (4) two fine clocks by Hohwü, of Amsterdam—one with break-circuit attachment; (5) chronographs, chronometers, etc.

The personnel consists, at present, of the director, one regular assistant, and a temporary assistant. The director, Dr. W. Valentiner, has begun with the meridian circle a series of observation of all stars down to the eighth magnitude between 0° and 20° of south declination, each star will be observed six times. So far about nine thousand observations have been made, and most of these have been reduced and published in parts 1 and 2 of the "Veröffentlichungen" of the observatory. The assistant, Dr. von Rebeur-Paschwitz, uses the refractor for observations of comets, occultations, etc.; his principal work is the micrometrical measurement of star-clusters; two groups will soon be finished. The filar micrometer has been carefully investigated. Herr von Rebeur has also completed an exhaustive discussion of comet 1882 I (Wells). The second assistant, Herr L. Stutz, makes regular observations with the transit instrument for the time-service of the observatory, and also observes moon-culminations and right ascensions of the fundamental stars for the southern zones of the "Astronomische Gesellschaft."

Kew (1886).—The magnetical and meteorological observations and observations for time are kept up. Sketches of sun-spots projected on the photo-heliograph screen are made in order to continue Schwabe's enumeration.

Kiel (1885).—Observations with the meridian circle and equatorial are continued, the equatorial having been provided with a new registering apparatus. The catalogue founded on the Helsingfors-Gotha zones is still unfinished.

Lawrence Observatory.—(*See* Amherst.)

Kis-Kartel (1886).—Private observatory of Baron Podmaniczky, near Budapest, Hungary. The principal instrument is a 7-inch refractor by Merz, with a mounting by Cooke. The work commences next year with double-star measures and physical observations of the sun, moon, and planets.

La Plata Observatory (1886).—The Government of the province of Buenos Aires is fitting up in La Plata an observatory which is to have a 31.5-inch reflector, an equatorial *coudé* of 17 inches, an 8-inch transit, a large Thollon spectroscope with objective of 9.8 inches, apparatus for celestial photography, and numerous smaller instruments. A time-service will be instituted, and a large amount of geodetic work will be done, including the measurement of an arc of a meridian. The observatory is to be under the direction of M. Beuf, late an officer in the French navy.

Leipzig (1885).—Dr. Harzer has gone to Pulkowa, and has been succeeded at Leipzig by Herr Schnauder. The zone observations and necessary reductions are being advanced as rapidly as possible. The equatorial has been used on comets and star-clusters.

Leyden Observatory (1885).—Prof. H. G. van de Sande Bakhuyzen's report is for the year ending September 15, 1885. The new 10½-inch equatorial, with objective by Clark, and mounting by Repsold, is ready for use. The 7-inch refractor was used for observations of comets. A series of measurements of artificial disks was made with Airy's double-image micrometer for the purpose of determining the systematic errors of the measures of the diameters of Mars and Uranus obtained in former years. The meridian circle was devoted to observations of fairly bright circumpolar stars. Some progress has been made with the reductions of the zone observations, 1874–'76.

Lick Observatory (1886).—The Lick Observatory will soon be counted as one of the active observatories of America. The formal opening and transfer to the University of California can not take place until the great telescope is mounted (probably in the summer of 1887), but Professor Holden already has one assistant at work—Mr. Keeler, who has been Professor Langley's assistant at Allegheny for a number of years.

The crown and flint lenses for the 36-inch objective arrived safely at Mount Hamilton on December 27, 1886, and have been packed away in a fire-proof vault in readiness for the mounting.

It is the intention to provide three lenses, the third a "photographic corrector" which can be slipped on in front of the other two. The Clarks found that the first piece of glass sent them for this lens showed signs of internal strain due to insufficient annealing, and the work of figuring was only undertaken at the risk of the makers, Feil & Co. The suspicion of strain proved well founded, for the disk burst into three pieces while upon the grinding tool. Another disk will be procured and should be ready by June 1, 1887. The cost of the objective was $52,000. The photographic lens will add several thousand dollars to this. The recent death of Feil père may cause serious delay in obtaining the glass for the third lens.

The mounting is under way in the workshops of Messrs. Warner & Swasey, of Cleveland, Ohio, and will be delivered at Mount Hamilton in June, 1887, for $42,000. It will contain many novel devices, among them an application of a modified form of the bicycle ball-bearings to the right ascension and declination axes, which will insure great ease of movement. The driving clock will have an electrical control.

The hemispherical dome of 70 feet interior diameter has been built by the Union Iron Works, of San Francisco, for $56,800. The question of an observing chair has been met by adopting Grubb's plan of moving the floor vertically 16 feet. Some such arrangement becomes absolutely necessary when we consider that the "spectroscopic length" of the telescope is some 5 feet more than the visual length, and the photographic length some 8 feet less; the eye-piece may be 7 feet from the base of the dome when the telescope is pointed to the zenith, or it may be 35 feet in the horizontal position. The floor will be raised in four minutes with a perfectly parallel motion, by hydraulic rams. The cost of the floor will be $14,500. A star spectroscope is to be made by Brashear, of Pittsburgh, for $1,000, and the micrometer by Fauth, of Washington, for $750.

The total cost of the observatory will be a little over $500,000, leaving nearly $200,000 available as a permanent endowment. The annual income of the observatory from all sources will be about $20,000.

In the summer of 1886 Prof. G. C. Comstock made an investigation of the Repsold meridian circle and a preliminary determination of the latitude. The resulting latitude of the north dome is $+ 37° 20' 25''.2$; the longitude given by the U. S. Coast Survey is $8^h 6^m 34^s.35$ west of Greenwich. A time-service is in operation over the whole Pacific system of railways from Ogden to El Paso. Volume 1 of the observatory publications is in press, and will be distributed in the early summer.

Professor Holden's plan for utilizing to the utmost the magnificent equipment under his charge must commend itself to every one. The plan is to relinquish the use of the 36-inch equatorial for certain hours of each day to distinguished astronomers, specialists, who may wish to turn its enormous power upon some one of the many unsolved problems of astronomy. Such astronomers may be invited to visit the observatory for periods of several months, and will be given every possible facility. The legislature of California has provided money for a permanent support of the observatory.

Lund (1885).—Dr. Dunér is principally occupied with stellar spectra and variable stars. Herr Laurin has observed with the meridian instrument a number of stars with large proper motion.

McCormick Observatory.—Professor Stone's report for the year ending June 1, 1886, states that the 26-inch equatorial has been employed chiefly in examining and sketching southern nebulæ. The nebula in Orion and the Trifid and Omega nebulæ have received special attention; many others have been studied, and two hundred and thirty-three new nebulæ have been discovered. "The features seen indicate that the performance of the instrument employed surpasses that of any of the great reflectors which have been used in the examination of nebulæ." Double stars, comets, and occultations by the moon have also been observed. Observations with the small equatorial for the revision of the 23° zone are now practically completed. Electric lamps are used for illuminating the circles and field of the great equatorial, and have proved most useful. The 45-foot dome revolves as easily as when first erected.

The cost of the observatory building and instruments was about $70,000, of which $64,000 was the gift of Leander J. McCormick. A working fund of $25,000 was given by William H. Vanderbilt, and an endowment of the directorship of $50,000 was subscribed by the alumni of the University of Virginia.

Professor Stone is assisted by Mr. F. P. Leavenworth and Mr. F. Muller. Part 2 of volume I, on the great comet of 1882, and part 3, on the nebula of Orion, have been issued during the year.

McGill College Observatory (1886).—A most thorough discussion of a series of longitude observations by Professor McLeod, at McGill College, and Professor Rogers, at Harvard College Observatory, has been published: the resulting longitude of the pier of the transit instrument at McGill Observatory being $4^h\ 54^m\ 18^s.543 \pm 0^s.043$ west of Greenwich. The center of the dome of the Harvard Observatory is assumed to be in longitude $4^h\ 44^m\ 30^s.993 \pm 0^s.041$ west of Greenwich.

Melbourne (1886).—Mr. Ellery has published the first installment of observations of southern nebulæ made with the great Melbourne reflector from 1869 to 1885. A description of the great 4-foot Cassegrainian reflector is given; and there are several lithographs of small nebulæ. Some fine results have been obtained in photography both of the moon and of stars and nebulæ.

Mexico. See Tacubaya.

Milan.—The 18-inch Merz-Repsold refractor was mounted and ready for work in May, 1886. The 8-inch glass has been used for double stars, comets, etc. Messrs. Rajna, Porro, and Abetti have been engaged in geodetic work.

Morrison Observatory (1886).—The work of the equatorial for 1886 has consisted of a series of observations on comets Fabry, Barnard, and Finlay (reduced and published or ready for publication); physical observations of Jupiter and phenomena of Jupiter's satellites, with a few observations of occultations by the moon. The meridian circle can be used, at present, only for time observations and for the determination of such star-places as are needed in equatorial work. A daily and efficient time-service is maintained on railroads extending to St. Louis, Chicago, and Kansas City, and thence south and southwest. Meteorological observations are kept up with regularity.

Professor Pritchett has prepared a small volume of the unpublished observations of former years. This is now passing through the press, and will be distributed as soon as practicable. The expense of publication is borne by Mrs. Berenice Morrison-Fuller, the founder of the observatory.

The annual income of the observatory is $2,160. This covers all expenses, including salaries. The director has no assistance, except that rendered by his daughters, and such as is afforded by a boy in handling the instruments and caring for the rooms.

Munich (1885).—The revision of Lamont's catalogue is progressing favorably. A number of stars from the southern Durchmusterung have been added to the observing list, to fill up gaps. Dr. Seeliger has finished a count of the stars in this southern extension of the Durchmusterung similar to the one already published for stars of the northern hemisphere. Dr. Bauschinger was obliged to devote two months of the year to "Militärische Verpflichtungen."

Nice (1886).—The refractor of 30 inches was provisionally mounted in August, and it is stated that the trials with it have given most excellent results.

O'Gyalla (1885).—The main work of the observatory has been the experimental determination of the mechanical energy of the radiations of thirty-four stars of the first and second magnitude. The spectroscopic "Durchmusterung" of a zone 0° to 15° is nearly completed. Sun-spots are observed regularly.

Oxford University Observatory (1886).—Professor Pritchard's report was read to the board of visitors on June 16. The photometrie measurement of the magnitudes of an equatorial zone of stars has been undertaken. Attention will be given to astronomical photography—a department of work for which the observatory is well equipped—directing investigations to, first, the relation which exists between the photometric and the photographic magnitude of stars; second, the reliable uniformity of the photographic film; third, the amount of astronomical accuracy attainable on the same.

Palermo (1885).—New comets, shooting stars, solar spots, and protuberances have been observed; drawings have been made of the planets, and atmospheric phenomena have been studied.

Paris (1885).—The report of Admiral Mouchez, presented to the council on the 22d of January, 1886, gives especial prominence to the work in astronomical photography. A reproduction is given of a photograph of the Pleiades taken by the Henry Brothers, and also an illustration of the instrument employed. We have already referred to many of the interesting results obtained. Three instruments have been used for photography; the first (aperture 6.3 inches), the experimental instrument used in 1884, has been employed in photometric researches. The second is a smaller instrument, aperture 4.3 inches, for photographing large comets and extended groups of stars. The third is the equatorial of 13 inches aperture, with which the more important work has been done.

The routine work has not, however, suffered; in the meridian service over sixteen thousand observations have been made by sixteen different observers; the instrument devised by M. Lœwy, the *equatorial coudé*, has been used for the observation of comets and minor planets, and the time-service, meteorological department, etc., are all in a most satisfactory condition. The reductions for the great catalogue were completed up to 8^h right ascension. The catalogue has been printed up to number 3,800.

Plonsk (1885).—Comets, double stars, etc., have been observed, and an interesting study of the atmospheric lines of the spectrum has been undertaken. Dr. Jedrzejewicz, the director, has made a new determination of the geographical co-ordinates of the observatory with the following result: Latitude, $+52^\circ\ 37'\ 40''$; longitude, $27^m\ 57^s.07$ east of Berlin.

Potsdam (1885).—Dr. Vogel's most interesting report occupies more than ten pages of the Vierteljahrsschrift (vol. 21, pp. 132–142). The instruments have been improved in many minor details, and several pieces of subsidiary apparatus have been added. Drs. Müller and Kempf have devoted considerable time to finishing the new determination of wave-lengths of the Fraunhofer lines. Drs. Vogel and Wilsing have been at work upon the spectra of new stars, spectra of comets, and spectra of solar spots and protuberances. Dr. Müller has made a number of photometric observations of the major and minor planets, while Dr. Wilsing has observed variable stars. Dr. Lohse has made a series of drawings of Jupiter, and has obtained one hundred and forty-six photographs of the sun; these latter, taken in connection with Dr. Spoerer's telescopic observations, will furnish ample material for the history of the spots. Dr. Lohse has also continued his series of photographs of star-clusters with gratifying success. Dr. Wilsing has carried on a very interesting series of experiments to determine the density of the earth. The third part of volume four and the fifth volume of the

Annals have been published. The library has increased to about thirty-seven hundred volumes.

Prague (1885).—Professor Safarik has devoted his attention to variable stars.

Princeton (1886).—The 23-inch equatorial has been used by Professor Young in micrometrical work upon close double stars, the satellites of Uranus and Neptune, the surface markings of Jupiter, and the details of Saturn. Comets are observed when they have become difficult objects for smaller instruments. Occasional spectroscopic observations are made of sun-spots, prominences, and comets. The institution has no endowment which would make it possible to undertake any extensive or continuous programme of work. The small observatory is used almost entirely for instruction in practical astronomy, this part of the work being under the immediate supervision of Professor McNeill.

Pulkowa (1886).—The annual report of Dr. Struve is for the year ending May 25, 1886. The great routine work, the determination of star-positions, has been continued as in former years. The 30-inch refractor, in the hands of Dr. Hermann Struve, has been employed in observing the faint double stars of Burnham's catalogue, the satellites of Mars, Saturn, and Neptune, the Maia nebula and Nova Andromedæ, which was easily visible on January 27. Dr. Hermann Struve speaks in the highest terms of the instrument, both as regards its optical power and its mounting, the movement of the dome, etc. Backlund has measured with the 4-inch heliometer the positions of Jupiter's satellites, for a determination of the mass of the planet and the orbits of the satellites. Hasselberg has been experimenting upon photography of the solar spectrum. The observatory has met with a severe loss in the recent death of Herr Wagner.

Radcliffe Observatory (1886).—Observations have been made of the sun, the moon throughout the lunation, occultations by the moon, and the phenomena of Jupiter's satellites. Volume 41, containing results for 1883, has been published.

Rio Janeiro (1886).—M. Cruls announces that the observatory is to be transferred to a new site, nearly on the same parallel as the present observatory, but two minutes of time farther west. M. Cruls has been commissioned by the Emperor of Brazil to have a photographic apparatus constructed similar to that at Paris, in order to co-operate in the proposed photographic survey of the heavens.

Rousdon (1886).—A private observatory erected in 1884 and 1885 by Mr. Cuthbert E. Peek at Rousdon, near Lyme Regis, Devon, England. The principal instruments are, a 6.4-inch equatorial objective by Merz, mounting by Cooke, a 2-inch Troughton & Simms transit, chronometers, etc. Beneath the equatorial room is a laboratory which is also fitted for photography. In 1886 the comets of the year and a list of long-period variables were observed, and transit observations were made for rating the chronometers. A volume containing observations of comets, Nova Andromedæ, etc., and meteorological observations from 1882 to 1885 has been published.

Smith College Observatory.—Professor Todd includes in his report of the Amherst Observatory a brief account of an observatory, the construction of which he has supervised for the trustees of Smith College (for young women), at Northampton, Massachusetts. A one-story brick building is divided into an equatorial room, photographic dark-room, library, clock-room, and transit-room. The equatorial is of 11 inches aperture, the objective by the Clarks, and mounting by Warner & Swasey. Incandescent lamps are provided for the illumination of the circles and micrometers. The transit-room will contain a 4-inch meridian circle. The approximate position of the new observatory is: Latitude, + 42° 19′ 7″; longitude, $4^h 50^m 32^s.9$ west of Greenwich.

South Evanston (1886).—Dr. Marshall D. Ewell has erected a small private observatory at South Evanston, Cook County, Illinois, 10.8 miles north of Chicago. The equatorial is a 6¼-inch Clark refractor mounted on a pier made of Portland cement and fine gravel so as to form practically a single piece of rock from top to bottom. The dome is 12 feet in diameter, built with ash ribs covered with tin, and turns on six iron wheels. The observatory is also provided with a 2¼ inch Troughton & Simms transit, sidereal and mean-time chronometers, and minor apparatus.

Stockholm (1885).—Investigations upon the motions of the different members of the solar system have absorbed the attention of the director and his assistants. The mean motions of the apsides of the planets Jupiter, Saturn, and Uranus are found to differ sensibly from the values assigned by Leverrier. Herr Shdanow has continued Gyldén's researches upon the lunar theory, and Dr. Harzer has contributed a valuable memoir upon the motion of Hecuba.

Strassburg.—Dr. Schur, previous to his departure for Göttingen, where he takes Klinkerfues' place, published a report, dated May 6, 1886, supplementary to his annual report of July, 1885. The principal meridian work was upon southern stars in the extension of the Durchmusterung, and Auwers' eighty-three southern fundamental stars and refraction stars. The moon was observed with the altazimuth; comets with the refractor. Dr. Kobold succeeds Herr Schur. Dr. Winnecke has been retired, at his own request, on account of ill health.

Tacubaya (1885).—The Observatorio Nacional, formerly at Chapultepec, is now at Tacubaya, about 6 miles from the city of Mexico. The final value of the longitude of the large meridian circle, from exchanges in 1885 with St. Louis, is $6^h 36^m 46^s.54 \pm 0^s.02$ west of Greenwich. (Astron. Jour., 7 : 62.)

Taschkent (1885).—The refractor was employed principally in observing sun-spots; comets and occultations were also observed. The meridian circle furnished the places of a number of comparison stars for comets and planets. Geographical positions were determined for six towns in central Asia.

Temple Observatory (1886).—Observations of double stars have been continued, and spectroscopic observations to determine the motion of stars in the line of sight.

United States Naval Observatory (1886).—No material change has been made in the character of the work. Professor Hall has used the 26-inch refractor in observations of Saturn, of double stars, and of satellites; and also for determinations of stellar parallax. No deterioration of the objective has been noticed since it was repolished ten years ago.

The transit circle has been employed in observations of the sun, moon, planets, and such stars as are necessary to complete the data for a transit-circle catalogue, which will contain all of the miscellaneous stars observed since the instrument was mounted, twenty years ago. The reductions are somewhat behindhand on account or the inadequate computing force. The 9.6-inch equatorial has been used in the observation of comets, asteroids, and the occultation of stars by the moon; and the Repsold meridian circle at Annapolis temporarily, under the direction of the Superintendent of the Washington Observatory, in the observation of a list of southern stars. The revision of Yarnall's catalogue and the reduction of recent observations with the prime vertical instrument are progressing favorably. Photographs of the sun have been taken with the photo-heliograph used during the transit of Venus. Ninety eight negatives showing spots were secured between January 11 and September 30, 1886.

The extensive time-service of the observatory is in an efficient state, and the chronometer tests inaugurated a few years ago have proved of great benefit to the naval service. Considerable attention has also been given to the examination of nautical instruments, thermometers, etc., for the Navy.

The volume for 1882, and Appendices I, II, and III to the volume for 1883 have been distributed.

Commodore Belknap was relieved from duty as Superintendent on June 7, 1886, by Commander A. D. Brown, and Commander Brown on November 15 by Capt. Robert L. Phythian.

The expenses of the observatory are met by annual appropriations from Congress, the naval officers (including professors) receiving the pay of their respective ranks. The pay of fourteen officers attached to the observatory December 1, 1886, aggregated $31,400.

The specific appropriation for the observatory for the year ending June 30, 1886, contains the following items: For pay of three assistant astronomers, $3,600; one clerk, $1,800; instrument maker, $1,500; four watchmen, $4,880; assistant for the 26-inch equatorial, $720; gardener, $1,000; seven laborers, $4,620; for miscellaneous computations, $1,200; purchase of apparatus and material for repairs of instruments, $2,500;

library, $1,000; repairs to buildings, fuel, gas, furniture, stationery, and contingent expenses, $3,900; freight on observatory publications sent to foreign countries, $366. The entire annual cost of the maintenance of the observatory may, therefore, be put at about $58,500;—$50,700 being for salaries and wages, and nearly $7,800 for other expenses. The item of salaries will vary considerably, of course, with the number and rank of line officers on duty, and it should be borne in mind that several of the officers are engaged upon work carried on at the observatory as a naval institution.

The sum of $100,000 is now available for the erection of a new observatory, and the plans prepared six or eight years ago are being revised, with a prospect of beginning work upon the new buildings in the course of a few months. The total cost of the buildings is limited to $400,000.

Warner Observatory.—Dr. Swift has confined himself to the discovery of new nebulæ and the search for comets. The instruments are: A 16-inch Clark equatorial, provided with a filar micrometer and many convenient accessories; a 4½-inch comet-seeker, and a sidereal clock by Howard. A spectroscope, to cost $1,000, has been ordered from Alvan Clark & Sons. A description of the observatory, with its instruments and work from 1883 to 1886, has been published as volume I of the observatory publications. This volume contains a list of four hundred and nine nebulæ discovered since July 9, 1883 (it is stated that five hundred and forty have been discovered in all), a list of the Warner astronomical prizes, and the full text of the Warner prize essays on comets and on the red "sky-glows."

Vanderbilt University Observatory, Nashville, Tenn.—This observatory is supplied with the following instruments:

Six-inch equatorial refractor, by T. Cooke & Sons, 8-foot focus, with hour circle divided to single minutes, and subdivided to 2^s by opposite verniers; and declination circle divided to 10′ and read by two verniers to 10″. There is also a third vernier reading to 15″, used for setting in declination, and read by the observer at the eye-piece with a small telescope. The instrument is supplied with eight eye-pieces, ranging from 60 to 600, and filar micrometer (bright field, dark wires only). A revolving disk with colored glasses gives a change of color of field,—a red one being found most useful, as it seems to permit observations of fainter objects with sufficient distinctness of the wires. A ring micrometer (not belonging to the observatory) is also used with the equatorial. A good driving clock gives a steady motion to the telescope. Two spectroscopes belong to this instrument—one, a direct-vision spectroscope by Merz & Mahler, the other by Grubb.

The equatorial room is surmounted by a hemispherical dome, revolving readily by hand on twelve pairs of wheels. The shutter is of light corrugated iron, in two sections; the upper section, two-thirds of the entire length, passes through the zenith to the back of the dome; the other part is drawn to one side, running on two light wheels, upon a projecting platform. This instrument has been used during the past year in the observation of comets, nebulæ, and the planets, and other miscellaneous work. Positions of all the comets have been obtained with either the ring or filar micrometer. Some experiments in celestial photography have been carried on, and good views of the moon obtained. The instrument cost about $1,900.

A 4-inch meridian circle, by Ertel, with circles 26 inches in diameter, divided to 3′. On the east pier is mounted a frame carrying four microscopes which read the circle to 0″.5. The reticule consists of thirteen vertical and two horizontal wires. The field or threads are illuminated at will. This instrument is reversible, and cost about $1,400.

The chronograph is one of Warner & Swazey's latest designs, and is used with either the equatorial or meridian circle. Cost, $375. The sidereal clock, by Dent, cost $500. The mean-time clock, by Howard, cost $400.

There is also a 3-inch altazimuth, by Cooke; and a 5-inch portable refractor, by Byrne. This latter instrument is not the property of the observatory. With it Professor Barnard has discovered a large number of comets.

The observatory building consists of a transit room, an equatorial room, and two computing rooms. The equatorial room is on the second floor, and is reached by a spiral staircase.

Washburn Observatory (1886).—This fine observatory possesses a 15½-inch Clark equatorial, with filar micrometer, a Repsold meridian circle, one sidereal and two mean-time clocks, a chronograph, chronometers, etc., besides the excellent 6-inch equatorial which formerly belonged to Mr. S. W. Burnham, and with which his first observations and measurements of double stars were made. This latter equatorial, together with a Fauth 3-inch transit, is mounted in a separate building of wood, called the students' observatory. The main building has, besides the rooms for the meridian circle and the large dome for the equatorial, a separate clock and computing room, a room for the electrical switch-board, time relays, etc., and a well furnished room for a library and director's study. There are also sleeping rooms for two assistants, one of whom is the meteorological observer whose records are printed in the annual volumes of the observatory. The officers of the observatory are a director, two assistant astromoners (one of whom is a lady), the meteorological observer, and a janitor. The library of the observatory is maintained by the generosity of the Hon. Cyrus Woodman, of Cambridge, Massachusetts, who has given, for this purpose, the sum of $5,000. One half the yearly interest from this sum is available for the purchase of new books, the other half going to increase the principal until it reaches a specified sum. The "publications" are printed at the expense of the State, and are issued when circumstances warrant. Four volumes have already been issued, and a fifth is nearly ready for publication.

The entire outfit of the observatory, in instruments and buildings, is due to the munificence of the late Governor Cadwallader C. Washburn, and cost not far from $50,000. A detailed list of the cost of some of the instruments is given in the volumes of publications of the observatory. All salaries and running expenses are paid by the regents of the university from the general fund. These have heretofore amounted to about $5,000 annually.

After the departure of Professor Holden, in December, 1885, the assistants of the observatory, Mr. Milton Updegraff and Miss Alice Lamb, completed the observations and reductions of the three hundred and three star list, and the reading of the proof-sheets for the publication of volume IV (1885) of the observatory reports. During the early summer of 1866 a careful study of the division errors of special diameters of the meridian circle was undertaken; also of its horizontal flexure. Observations of the latitude made with the meridian circle since its first mounting show a discordance between circle east and circle west of about 1″. The cause of this is now an object of study, and is believed to be mainly due to flexure. The large equatorial has been kept employed upon double stars, and in January, 1887, a series of measurements was made with its filar micrometer upon the position of Sappho (80) at opposition. An index to those stars in the six Greenwich catalogues not occurring in Flamsteed, has been prepared by Miss Lamb, and will be published in volume V.

The usual routine work of the observatory, such as controlling the clocks in the city of Madison, the time bells in the university recitation rooms, and the daily furnishing of time-signals to the railroads entering Madison, has been faithfully attended to. Professor Holden's successor as director of the observatory is Prof. John E. Davies.

Washington University Observatory, St. Louis (1886).—Instruction in theoretical and practical astronomy is the main object of the observatory. An extensive time-service is maintained, and the observatory co-operates with Government field parties in geodetic work. Prof. H. S. Pritchett has one assistant. The income is derived from the general university endowment and from the time-service.

Woodside Observatory.—Mr. Charles L. Woodside has a small private observatory at East Boston, Massachusetts, its approximate position being latitude +42° 22′ 39″; longitude $4^h\ 44^m\ 9^s$ west of Greenwich. The principal instrument is a silvered-glass reflector of 6½ inches aperture and 5 feet focal length; the mirror is by Brashear, of Allegheny, and the mounting by Mr. Woodside himself. This is to be devoted for several years to a careful and systematic study of the colors of all stars brighter than the sixth magnitude visible at Boston. Mr. Woodside has devised a method of computing occultations which he has described in the Sidereal Messenger for July, 1886.

Yale College Observatory (1886).—For the year ending June 1, 1886, Dr. Elkin reports progress in his work of triangulation in the Pleiades with the 6-inch heliometer. He proposes to observe ten of the brightest stars in the northern hemisphere for parallax. Mr. A. Hall, jr., has been engaged in observations of Titan with the heliometer, with a view to a new determination of the mass of Saturn.

Zürich (1885).—Dr. Rudolf Wolf is occupied almost entirely with sun-spot statistics. He fixes the last "maximum" of spots at 1883.9.

ASTRONOMICAL INSTRUMENTS.

Barometer coefficients for clocks.—Dr. Hilfiker has determined the barometric coefficient—or the variation in rate for a change of 1 millimeter in the atmospheric pressure—for a Winnerl clock with gridiron pendulum comparing the Winnerl clock with the Hipp normal electric clock at Neuchâtel on each night of observation.

These comparisons, made between August, 1884, and September, 1885, give an idea of the influence of the mode of compensation upon the value of the barometric coefficient. The following table shows the results obtained at Geneva and at several other observatories for their normal clocks:

Place.	Compensation.	Barometric coefficient.
Neuchâtel	Winnerl, gridiron pendulum	$0^s.010$
Do	Hipp electric clock	0.012
Pulkowa	Mercury compensation	0.013
Leyden	do	0.015
Berlin	do	0.015
Zürich	do	0.015
Washburn Observatory	do	0.012

(Bull. astron., December, 1886.

The new optical glass.—Nature for October 28, 1886, contains an interesting account of the experiments of Professor Abbé and Dr. Schott in their endeavors to produce a glass of such chemical composition that it may be possible to make lenses free from the secondary chromatic aberration and other defects. For the microscope lenses already made of the new glass Professor Abbé claims great superiority in many important respects.

Electric illumination.—Prof. Ormond Stone, of the McCormick Observatory, uses for illuminating the circles and micrometer wires of the great equatorial, Edison incandescent lamps of one-candle power, run by what is known as the "Orne motor battery," or by the "Edco battery," the latter being used where a more continuous light is required. The success of the experiment here has resulted in the use of electricity, at least for circle illumination, at West Point, Yale and other observatories.

In the Greenwich spectroscopic observations, "a slip of metal coated with Balmain's luminous paint, inserted immediately behind the measuring pointer, has been frequently employed to give a phosphorescent illumination of the field."

Gautier's mercury-basin for nadir and reflection observations, described in last year's report, has been tried at the Melbourne Observatory, and gives highly satisfactory results.

We have already referred, in the report of the Lick Observatory, to the completion of the 36-inch objective and its removal to Mount Hamilton.

MISCELLANEOUS.

Astronomical prizes.—At the meeting of the Paris Academy of Science on December 27, 1888, the Lalande prize was awarded to Dr. Backlund for his work on Encke's comet; the Valz prize to M. G. Bigourdan for investigation of personal equation in the measurement of double stars; the Damoiseau prize to M. Souillart for his theoretical researches on Jupiter's satellites, and an "*encouragement*" of 1,000 francs to M. Obrecht for his study of the application of photometry to the eclipses of Jupiter's satellites. The Bordin prize was awarded to M. R. Radau for his work on the theory of astronomical refraction.

The gold medal of the Royal Astronomical Society was awarded to Mr. G. W. Hill for his researches on the motion of the moon.

The Rumford medal of the Royal Society, the Rumford gold and silver medals of the American Academy of Arts and Sciences, and the Draper medal of the National Academy were awarded to Prof. S. P. Langley for his researches with the bolometer.

The Watson medal of the National Academy, with an honorarium of $100, was awarded to Dr. B. A. Gould.

The Royal Society of Edinburgh awarded the Makdougall-Brisbane prize to Dr. Edward Sang for his communication on the need for decimal subdivisions in astronomy and navigation.

The Warner prizes, $100 for each comet discovered (and announced under certain conditions), were conferred, in 1886, as follows: Mr. Brooks, $300; Mr. Finlay, $100; Mr. Barnard, $100.

The American Astronomical Society of Brooklyn.—Among the papers read in 1886 were: "The Earth's Temperature," by H. M. Parkhurst; "Faye's Nebular Speculations," by G. P. Serviss; "Origin of Meteorites," by G. W. Coakley and H. M. Parkhurst. The president of the society is Mr. S. V. White, the secretary, Mr. G. P. Serviss, Brooklyn, New York.

Baltimore Amateur Astronomical Society.—A number of gentlemen of Baltimore have organized an amateur astronomical society, meeting each month for the presentation of papers and discussion of observations. Dr. Hooper, 1425 Linden avenue, the secretary, has a 5-inch Clark equatorial; Mr. Gildersleeve a 6-inch equatorial with object-glass by Dr. C. S. Hastings; Mr. Stahn a 4-inch glass, also by Dr.

Hastings, and Mr. Numsen a 4-inch Cooke equatorial, mentioned in the report last year under the "Denmore Observatory." Physical observations are made of the sun, moon, planets, and comets. Mr. Stahn has kept a record of sun-spots, and has devised numerous ingenious accessories for his instruments.

Astronomical Journals.—The re issue of the "Astronomical Journal" by Dr. Gould is cordially welcomed, particularly by American astronomers, who are thereby furnished with a more prompt means of intercommunication than has been heretofore available. An interval of twenty-five years occurs after No. 144; and No. 145, bearing the date of November 2, 1886, begins volume VII. The Journal is edited by Dr. Gould, as before, at Cambridge, Massachusetts.

A new monthly astronomical review, Revista do Observatorio, has appeared, under the editorship of Dr. Luis Cruls, of the Imperial Observatory of Rio Janeiro. The journal will be found interesting and valuable by amateurs and those interested in the progress of astronomy, as well as by professional astronomers.

We are at the same time obliged to record the discontinuance of the Astronomical Register, with the completion of its twenty-fourth volume, December, 1886, No. 288.

The Influence of astigmatism on Astronomical Observations.—It appears from Professor Seeliger's researches that this malformation in the eye, which is far from uncommon, exerts a greater influence on astronomical measurements than is generally supposed. Thus, he shows that a systematic error in a series of observed declinations amounting to $0''.26$ may very well be due to it; and it appears that the discordances in observed position angles of double stars—depending on the inclination of the line joining the components to the vertical—with which the measures of some observers are affected, may be referred to the same cause. (Nature, November 18, 1886.)

Determination of time.—Döllen has described in the Nachrichten (114: 289) an expeditious method of obtaining a clock correction where great refinement is not necessary. The observation is made in the vertical of the pole-star, and tables have been published by the Pulkowa Observatory giving for some sixty odd stars all the quantities which are independent of the latitude, required in the formulæ. The work of reduction is made as brief as possible.

An astronomical directory.—M. A. Lancaster, the librarian of the Brussels Observatory, has published a very useful list of observatories, their geographical co-ordinates, and the astronomers attached to them; of astronomical societies and institutions, and of reviews and journals specially devoted to astronomy. The little book contains also a list of names and addresses of astronomers not attached to any observatory, and of amateurs, as well as a list of makers of astronomical instruments.

Miss Clerke's admirable "Popular History of Astronomy during the

Nineteenth Century" has been so widely reviewed that it seems unnecessary to do more than merely to mention it by title here. The book is "untechnical," and the "terse and vigorous" style makes it most interesting from beginning to end. There are numerous references to the original sources of information.

Professor Young's "Ten Years' Progress in Astronomy" has been reprinted in the Sidereal Messenger (vol. 6) and Nature (vol. 35).

ASTRONOMICAL BIBLIOGRAPHY, 1886.

The following bibliography is arranged by subjects, and contains journal articles and reprints from transactions of societies, as well as more formal publications. No pretense is made to completeness, even to the extent of including all titles that have come under the compiler's notice, and, in some cases, where it has not been possible to examine the publications themselves, the imprints, etc., may be imperfect. The prices quoted are generally taken from Friedländer's Naturæ Novitates, in German "mark" (1 mark = 100 pfennige = 1 franc 25 centimes = 25 cents, nearly).

It is hoped that the abbreviated titles of journals will be intelligible without special explanation. ("Compt. Rend." is, of course, the Comptes rendus hebdomadaires des séances de l'Académie des sciences, Paris, and "Month. Not." the Monthly Notices of the Royal Astronomical Society.) Among the imprint and other abbreviations there occur:

Bd. = Band.
d. = die, der, del, etc.
ed. = edition.
hrsg. = herausgegeben.
il. = illustrated.
k. k. = kaiserlich königlich.
Lfg. = Lieferung.
M. = mark.
n. d. = no date.
n. p. = no place of publication.
n. F. = neue Folge.
n. s. = new series.
p. = page.
p* = page of this summary.
pl. = plates.
pt. = part.
Rev. = Review.
s. = series.
sh. = shilling.
v. = volume.

The alphabetical arrangement is made to serve as an index to the present record, by inserting after the subject-heading, the pages of this review (p*—) on which the different subjects are noticed.

In the references to journals the volume and page are simply separated by a colon; thus: 5:81 indicates volume 5, page 81.

Almanacs. *See* EPHEMERIDES and ALMANACS.

Arago.

FLAMMARION (C.): Le centenaire d'Arago. L'Astron., 5:81, 131, 273.

Asteroid 24.

MÖNNICHMEYER (C.): Genäherte Berechnung der absoluten Störungen der Themis durch Jupiter. 32 p. 8°. Kiel, 1886.

Asteroid 107.

MATHIESSEN (B.): Bahn des Planeten (107) Camilla. 34 p. 8vo. Kiel, 1886.

Asteroid 153.

KUHNERT (F.): Die Definitiven Elemente des Planeten (153) Hilda. 35 p. 8vo. Wien, 1886 ....(M. 0.60)

Asteroid 220.

BIDSCHOF (F.): Untersuchungen über die Bahn des Planeten (220) Stephanie. 16 p. 8vo. Wien, 1886..(M. 0.35)

Asteroid 236.

BIDSCHOF (F.): Bestimmung der Bahn des Planeten (236) Honoria. 30 p. 8vo. Wien, 1886 ....(M. 0.50)

Asteroid 237.

VON OPPOLZER (T.): Bahnbestimmung des Planeten (237) Cœlestina. 17 p. 8vo. Wien, 1886 ....(M. 0.30)

Asteroids, p* 135.

MÜLLER (G.): Beobachtungen über den Einfluss der Phase auf die Lichtstärke kleiner Planeten. Astron. Nachr., 114: 177-196.

N[EWTON] (H. A.): Relation of asteroid orbits to that of Jupiter. Am. J. Sc., 3. s., 31, = 131: 318.

PARMENTIER (*Gén.*): Distribution des petites planètes dans l'espace. L'Astron., 5: 143.

SVEDSTRUP (A.): Les petites planètes entre Mars et Jupiter; une recherche statistique. Astron. Nachr., 115: 49-76.

TYERMAN (T. F.): The asteroids and the theory of their formation. 30 p. 8vo. London, 1886..(M. 2.20)

Astronomy.

PICKERING (E. C.): A plan for the extension of astronomical research. 11 p. 8vo. Cambridge, 1886.

Astronomy (Descriptive).

BOWEN (E. A.): Astronomy by observation. 90 p. il. 4to. New York, 1886. (M. 5.)

FÖRSTER (W. J.): Populäre Mittheilungen zum astronomischen Theile des königlichen preussischen Normalkalenders für 1887. 7 p. 8vo. Berlin, 1886..(M. 1.)

KLEE (F.): Unser Sonnensystem. 3. ed. 12 + 80 p. 8vo. Mainz, 1886..(M. 1.75)

LOCKYER (J. N.): The sun and stars. il. Nature, 33: 399, 426, 469, 499, 540; Nature, 34: 205, 227, 280.

NEISON (E.): Astronomy; a simple introduction to a noble science. London, 1886.

NOBLE (W.): Hours with a three-inch telescope. 6 + 122 p. 1 map. 12mo. London, 1886 ....(M. 4.70)

PROCTOR (R. A.): Expanse (The) of heaven: a series of essays on the wonders of the firmament. New ed. 308 p. 8vo. London, 1886 ....(M. 5.30)

——: Orbs (The) around us. New ed. 8vo. London, 1886 ....(M. 5.30)

——: Others worlds than ours. New ed. 8vo. London, 1886 ....(M. 5.30)

——: Our place among infinities. New ed. 320 p. 8vo. London, 1886.(M. 5.30)

——: Star primer. 8vo. London, 1886 ....(M. 2.70)

TUXEN (J. C.): Stjærneverdenen. 4. udgave ved C. F. Pechüle. Levering 5. 64 p. 8vo. Kjöbenhavn, 1886..(M. 1.10)

Astronomy (History of).

FAVARO (A.): Carteggio inedito di Ticone Brahe, Giovanni Keplero, e di altri celebri astronomi e matematici dei secoli XVI e XVII, con Giovanni Antonio Magini . . . [etc.]. 16+522 p. 8vo. Bologne, 1886.

Rev. by Günther (S.): Vrtljschr. d. astron. Gesellsch., 22: 66-72. 1887.

LANGE (L.): Der Bewegungsbegriff während der Reformation der Himmelskunde von Copernicus bis zu Newton. (1543-1687.) 69 p. 8vo. Leipzig, 1886.

Astronomy (Progress of).

Klein (H. J.): Die Fortschritte der Astronomie, 1886. 112 p. 12mo. Leipzig, 1887.

[Swift (L.)]: Astronomical phenomena and progress [in 1885]. Appleton's Ann. Cyc., n. s., 10: 47–56.

Winlock (W. C.): An account of the progress in astronomy in the year 1885. 114 p. 8vo. Washington, 1886 ....(M. 3)

Repr. from: Smithsonian Report for 1885.

Young (C. A.): Ten years' progress in astronomy. 1876–1886. 32 p. 12mo. New York, 1886.

Repr. from: Trans. N. Y. Acad. Sc., 5.

Astronomy (Spherical and Practical).

Brinkley (B.): Astronomy: . . . additional chapters by J. W. Stubbs and F. Brünnow. 3. ed. enl. 350 p. 8vo. London, 1886....................(M. 6.30)

Israel-Holtzwart (K.): Elemente der theoretischen Astronomie. il. 8vo. Wiesbaden, 1886...(M. 25)

Merrifield (J.): A treatise on nautical astronomy for the use of students, 364 p. 8vo. London, 1886...(M. 7.80)

Bonn Observatory.

Astronomische Beobachtungen auf der Sternwarte . . . zu Bonn. Hrsg. von E. Schönfeld. 8. Bd. Bonner Sternverzeichniss. 4. Section. 56 + 459 p. 4to. Bonn, 1886..(M. 20)

Bonner Sternkarten. 2. Serie. Atlas der Himmelszone zwischen 1° und 23° südlicher Declination für den Anfang des Jahres 1855 . . . bearbeitet von E. Schönfeld. I. und II. Lieferungen. 4 p. 12 maps. fol. Bonn, 1886.

Vollständig in 4 Lieferungen, 24 Sternkarten. Jede Lieferung, M. 12.

Bordeaux Observatory.

Annales de l'observatoire de Bordeaux, publiées par G. Rayet. Tome 1. 119 + 218 p. 4to. Paris and Bordeaux, 1885...........................(M. 25.50)

Calendar.

Förster (W. J.) and Lehmann (P.): Die veränderlichen Tafeln des astronomischen und chronologischen Theiles des k. preussischen Normalkalenders für 1887, 119 p. 8vo. Berlin, 1886 ....(M.

Fritche (H.): Chronology and the construction of the calendar. Chinese computation of time. 92 p. 8vo. St. Petersburg, 1886.

Cape of Good Hope Observatory.

Annals of the Royal Observatory . . . Vol. 2, pt. 1. Observations of the great comet, 1882, II, 25 p., 4 pl., 6 phot. 4to. n. p. [1886.]

Chronograph.

Hough (G. W.): Description of a printing chronograph. il. Sid. Mess., 5: 161–167.

Chronometers.

[U. S. Naval] Observatory temperature room, and competitive trials of chronometers in 1884 and 1886. 35 p, 9 pl. 4to. Washington, 1886.

Circle-divisions. *See, also,* Meridian circle; Pulkowa.

Schreiber (O.): Untersuchung von Kreistheilungen mit zwei und vier Mikroskopen. Ztschr. f. Instrmknd., 6: 1.47.

Clocks.

Buckney (T.): Superiority of zinc and steel pendulums. Month. Not., 46: 462–469.

Hilfiker (J.) Ueber den Gang der Winnerl'schen Pendeluhr der Sternwarte zu Neuchâtel. Astron. Nachr., 114: 391.

——: Sur la marche de la pendule astronomique Winnerl de l'observatoire de Neuchâtel. 14 p. 12mo. Neuchâtel, 1886.

Repr. from Bull. soc. d. sc. nat d. Neuchâtel 15: 21–32.

Clocks—Continued.

KÜSTNER (F.): Ueber den Gang der auf der Berliner Sternwarte in luftdichtem Verschluss aufgestellten Pendeluhr. [Tiede, Nr. 400.] Astron. Nachr., 114: 391.

Comet Biela. p* 125. *See, also,* METEORS.

NEWTON (H. A.): The story of Biela's comet. Am. J. Sc., 3. s., 31=131: 81–94. *Also* Nature, 33: 393, 418.

ZENKER (W.): Ueber den Biela'schen Cometen. Astron. Nachr., 114: 75.

Comet Brorsen.

MONK (W. H. S.): [Possible identity with comets of 1661, 1092, and 574.] Obsry., 9: 229, 259.

Comet Encke. p* 119.

BACKLUND (O.): Comet Encke. 1865–1885. 41 p. 4to. St.-Pétersbourg, 1886.
Mém. Acad. imp. de Sc. de St. Pétersb., 7. s., vol. 38. no. 8.

——: [Note on his recent researches on Encke's comet.] Astron. Nachr., 114: 225–230.

——: Comet Encke. I. Bearbeitung der Erscheinung 1885 und die Verbindung desselben mit den vier Vorhergehenden Erscheinungen. Mél. math. et astron. tirés du Bull. Acad. imp. d. Sc. de St. Pétersb. 6: 463–492.

Comet Faye.

SHDANOW (A.): Recherches sur l'orbite intermédiaire de la comète de Faye dans la proximité de Jupiter en 1841. 24 p. 4to. St.-Pétersbourg, 1886... (M. 0.80)
Mém. Acad. imp. de Sc. de St.-Pétersb., 7. s., vol. 33, no. 3.

Comet Halley.

CELORIA (G.): Sull' apparizione della cometa di Halley avvenuta nell' anno 1456. 8vo. Milano, 1885.

Comet Pons-Brooks.

KIRKWOOD (D.): Comets 1812 I and 1846 IV. Sid. Mess., 5: 13.

SCHULHOF (L.) and BOSSERT (J.-F.): La comète Pons-Brooks dans l'apparition de 1883–'84. Bull. astron., 3: 387–393.

Comet Tempel-Swift. p* 119.

BOSSERT (J.): Orbite de la comète Tempel-Swift. [1869 III and 1880 IV.] Bull. astron., 2: 550; 3: 23, 65.

Comet 1366.

LYNN (W. T.): [Orbit of] the comet o. 1366. Obsry., 9: 282–284.

Comet 1873 VII.

SCHULHOF (L.): Recherches sur l'orbite de la comète 1873 VII. [Coggia-Winnecke.] Bull. astron., 3: 125, 173, 265.

Comet 1877 III.

PÖNISCH (R.): Definitive Bahnbestimmung des Cometen 1877 III. Astron. Nachr., 115: 161–190.

Comet 1877 VI.

LARSSÉN (R.): Definitive Bahnbestimmung . . . [etc.]. Astron. Nachr., 116: 23–26.

Comet 1881 VIII.

OLSSON (K. G.): Bestimmung der Bahn . . . [etc.]. Astron. Nachr., 114: 201–206.

Comet 1882 II.

[JONES (J.) and LEAVENWORTH (F. P.)]: [Observations of the] tail of comet 1882 II. 17 p., 6 pl. 4to. Univ. of Va., 1886.
Pub. McCormick Obsry., vol. 1, pt. 2.

Comet 1882 II—Continued.

KREUTZ (H.): Ueber das System der Cometen 1843 I, 1880 I und 1882 II. Astron. Nachr., 114: 73.

OBSERVATIONS at the Cape of Good Hope. 25 p., 4 pl. 6 phot. 4to. n. p. [1886.]
Ann. Roy. Obsry., C. of G. Hope, vol. 2, pt. 1.

Comet 1883 II.

TENNANT (J. F.): Orbit of Comet II, 1883, discovered by Mr. Ross. Month. Not., 47: 24–26.

Comets, p* 118.

FIEVEZ (C.): Recherches sur le spectre du carbone dans l'arc électrique en rapport avec le spectre des comètes et le spectre solaire. 4 p., 4to; 3 pl., fol. Bruxelles, 1885 .... (M. 6.)

GALLE'S catalogue of comets from 1860 to 1884. Trans. from Astron. Nachr., 2665–2666 by W. C. Winlock. 23 p. 8vo. [Northfield 1886] .... ($0.50)
Repr. from Sid. Mess., Nov., 1885; Jan. and Feb., 1886.

KLEIBER (J.): Vertheilung der Knoten der Planeten- und Cometen Bahnen. Astron. Nachr., 115: 135–140.

MEYER (M. W.): Ueber die Bahn eines unsichtbaren Cometen. Astron. Nachr., 114: 70.

MONCK (W. H. S.): Companion comets. Obsry., 9: 279, 309.

PROCTOR (R. A.): Whence came the comets? 19th Cent., 19: 689–696.

STONE (O.): Computation of the position in orbit of a particle in the tail of a comet. Annals of Math., 2: 60–63.

WILSON (H. C.): Our knowledge of comets. Sid. Mess., 5: 257–262.

Comets and Meteors.

CORRIGAN (S. J.): The principal comet-meteor streams. Sid. Mess., 5: 145–148.

DENNING (W. F.): Cometary meteor showers. Sid. Mess., 5: 106–111.

——: Meteor shower of Halley's comet. Month. Not., 46: 396–398.

MONCK (W. H. S.): Comets and meteors. Obsry., 9: 331.

PROCTOR (R. A.): Origin of comets and meteors. Knowl., 9: 123–125.

WEISS (E.): Notiz über den Radiationspunkt von Meteoren aus der Bahn des Cometen [1886 III]. Astron. Nachr., 114: 399.

Constellations.

LYNN (W. T.): Nomenclature of the constellations near the south pole. Obsry., 9: 255–257.

Cordoba Observatory.

RESULTADOS del Observatorio Nacional Argentino en Córdoba. Vol. 14. Catálogo general. 15 + 650 p. 4to. Córdoba, 1886.

Corona (Solar), p* 130.

HUGGINS (W.): [Photography of corona without an eclipse not confirmed by observations on August 29, 1886.] Science, 8: 303. *Also* Nature, 34: 469. *Also* Astron. Nachr., 115: 191.

LYNN (W. T.): Probable ancient view of the solar corona without an eclipse. Obsry., 9: 128.

Cosmogony.

MEYER (M. W.): Kosmische Weltansichten; astronomische Beobachtungen und Ideen aus neuester Zeit. 8vo. Berlin, 1886 .... (M. 5)

WOLF (C.): Les hyphothèses cosmogoniques. Examen des théories scientifiques modernes sur l'origine des mondes, suivi de la traduction de la Théorie du ciel de Kant. 8vo. Paris, 1886 .... (M. 6)

Day (Astronomical), p* 133. *See, also,* TIME (Universal).

D'ABBADIE (A.): The proposed change in the astronomical day. [Favors it.] Obsry., 9: 227–229.

Day—Continued.

Backhouse (T. W.): Universal time. Obsry., 9: 288, 335.

Ball (R. S.): [Opinion against the proposed change.] Obsry., 9: 100.

Christie (W. H. M.): Remarks on the proposed change of the astronomical day. 3 p. 4°. [Greenwich, 1885.]

Dreyer (J. L. E.): Proposed change [etc.]. Obsry., 9: 130.

Hall (A.): [Opinion of astronomers at the U. S. Naval Observatory against the proposed change.] Obsry., 9: 161.

Noble (W.): [Opinion in favor of proposed change.] Obsry., 9: 258.

Weiss (E.): Zur Frage der Weltzeit. 37 p. 8vo. Wien, 1886 ....(M. 0.80)

Opposed to change in astronomical day.

Day (Mean solar).

Gaillot (A.): Sur la mesure du temps. Bull. astron., 3: 221–232.

Day (Sidereal).

Rapin (H.): Le jour sidéral et la rotation de la terre. L'Astron., 5: 416–420.

Declinograph.

Knorre (V.): Genauigkeit der Zonen-Beobachtungen, welche mit Anwendung des sogen. Declinographen am Berliner Aequatoreal ausgeführt werden. Astron. Nachr., 114: 307–312.

Double stars. p* 108.

Birkenmajer (L.): Ueber die durch die Fortpflanzung des Lichtes hervorgerufenen Ungleichheiten in der Bewegung der physischen Doppelsterne. Analyse der Bahn ξ Ursæ Majoris. 76 p. 8vo. Wien, 1886 ....(M. 1.20)

Repr. from: Sitzungsb. d. k. Akad. d. Wissensch., Math-naturw. Cl., Wien, Bd. 93.

Gore (J. E.): Orbit of the binary star β Delphini. Proc. Roy. Irish Acad., 2s., 4: 538–543.

——: Orbit of the binary star $O\Sigma$, 234. *Ibid.*, 586.

Hoff (E.): Trennbarkeit der Doppelsterne in Fernrohren von verschiedener Grösse. Sirius, 19: 252–256.

Mache (I.): Auflösbarkeit der Doppelsterne in Fernrohren von verschiedener Grösse. Sirius, 19: 178–183.

Schur (W.): Bahnbewegung des Doppelsterns 70 Ophiuchi. Astron. Nachr., 114: 105.

Double stars (Measures of).

DeBall (L.): Doppelsternbeobachtungen. Astron. Nachr., 115: 273–282.

Engelmann (R.): Doppelsternmessungen. Astron. Nachr., 115: 81–96.

Perrotin (J.): Mesures micrométriques d'étoiles doubles faites à l'Observatoire de Nice. 5. series. Astron. Nachr., 115: 193–215.

Young (C. A.) and McNeill (M.): Observations of the companion of Sirius. [1883–1886.] Sid. Mess., 5: 182.

Double stars. (Measures of, Personal equation in).

Bigourdan (G.): Sur l'équation personnelle dans les mesures d'étoiles doubles. 74 p. 4to. Paris, 1886.

Wilson (H. C.): Personal errors in double-star observations. Sid. Mess., 5: 174–179. *Also* [Abstr.]: Obsry., 9: 297–301.

Dresden.

Observations astronomiques faites par B. d'Engelhardt dans son observatoire à Dresde., 1 partie., 220 p. 4 pl. 4to. Dresde., 1886....................(M. 20)

Earth. p* 133.

Ball (R. S.): Note on the astronomical theory of the great ice age. Nature, 34: 607; 35: 53.

Faye (H.): Sur la constitution de la croûte terrestre. Compt. Rend., 102: 651, 786.

Earth—Continued.

LORENTZ (H. A.): Influence du movement de la terre sur les phénomènes lumineaux. Arch. néerl. d. sc. exactes, etc. Harlem, 21: 103–176.

ZANOTTI-BIANCO (O.): Il problema meccanico della figura della terra esposto secondo i migliori autori. 2 v. 8to. Roma, 1880–'85.

Rev.: Bull. astron., 3: 397–399.

Eclipse of the Sun, 1887, Aug. 19.

FRANZ (J.): Anleitung zur Beobachtung der totalen Sonnenfinsterniss in Ost- und Westpreussen am Freitag den 19. August, 1887. 8 p. 4to. Königsberg, 1886. (M. 0.30)

Eclipses.

MAHLER (E.): Astronomische Untersuchungen über in hebräischen Schriften erwähnte Finsternisse. Theil II. Die prophetischen Finsternisse. 20 p. 8vo. Wien, 1886. (M. 0.40)

Eclipses of the Sun. p* 129.

PROCTOR (R. A.): Total solar eclipses. Fortnight. Rev., n. s., 40: 407–422.

SCHRAM (R.): Beitrag zur Hansen'schen Theorie der Sonnenfinsternisse. 16 p. 8vo. Wien, 1886. (M. 0.40)

Edinburgh Observatory.

ASTRONOMICAL observations made at the Royal Observatory, Edinburgh; being vol. XV, for 1878 to 1886, containing only the remainder of the star catalogue, discussion and ephemeris for 1830 to 1890, of which the first four hours appeared in vol. XIV. By C. Piazzi-Smyth. 6 + 1034 p. 4to. Edinburgh, 1886.

Ephemerides.

AMERICAN ephemeris and nautical almanac for the year 1889. 1. ed. 6 + 517 + 8 p. 4to. Washington, 1886 .... ($1)

ANNUAIRE de l'Observatoire de Bruxelles. Année 53, 1886. 314 p. 16mo. Bruxelles, 1886 .... (M. 150)

ANNUAIRE pour l'an 1887, publié par le Bureau des longitudes. 891 p. 16mo. Paris, [1886. ?]

ANUARIO del Observatorio astronómico nacional de Tacubaya para el año de 1887. 325 p. 16mo. México, 1886.

ASTRONOMISCHER Kalender für 1887. Hrsg. von der k. k. Sternwarte in Wien. 159 p. 8vo. Wien, 1886 .... (M. 1.60)

BERLINER astronomisches Jahrbuch für 1888. 542 p. 8vo. Berlin, 1886.

CHARRIER (A.): Effemeridi del sole, della luna e dei principali pianetini . . . per l' anno 1887. 29 p. 8vo. Torino, 1886.

CLARK (L.) and SADLER (H.): The star-guide: a list of the most remarkable celestial objects visible with small telescopes . . . [etc.]. 16 + 48 p. 8vo. London, 1886 .... (M. 5.30)

COMPANION (Annual) to the Observatory. Obsry., 10: 1–48. 1887. *Also*, Reprint.

CONNAISSANCE des temps . . . pour l'an 1888. 968 p. 8vo. Paris, 1886.

FLAMMARION (C.): Annuaire astronomique pour 1887. L'Astron., 6: 1–21. 1887.

LOEWY (M.): Ephémérides des étoiles de culmination lunaire et de longitude pour 1886. 38 p. 4to. Paris, 1886 .... (M. 3)

NAUTICAL. (The) almanac and astronomical ephemeris for the year 1890. 8vo. London, 1886.

Equatorials. *See, also,* TELESCOPES.

HILGER (A.): New form of governor for the driving-clocks of equatorials. il. Month. Not., 46: 155.

Flexure.

HARKNESS (W.): On the flexure of meridian instruments and the means available for eliminating its effects from star places. 28 p. 4to. Washington, 1886 .... (M. 3)

Wash. Obsns., 1882, App. III.

Galileo.

MURPHY (*Rev.* J.): The case of Galileo. 19th Cent., 19: 722–739.

Glass (Optical).

CZAPSKI (S.): Mittheilungen über das glastechnische Laboratorium in Jena und die von ihm hergestellten neuen optischen Gläser. Ztschr. f. Instrmknd., 6: 293, 335.

NEW (The) optical glass [of Abbé]. Nature, 34: 622.

SCHJERNING (W.): Absorption der ultravioletten Lichtstrahlen durch verschiedene optische Gläser. 38 p. 8vo. Berlin, 1886. .... (M. 1.50)

Globes (Astronomical).

HEELE (H.): Apparat zur Orientirung an der Himmelskugel. Ztschr. f. Instrmknd., 6: 19–22.

Greenwich Observatory.

ASTRONOMICAL and magnetical and meteorological observations . . . 1884. 924 p. pl. 4to. London, 1886.

REPORT of the astronomer royal. [1886, May 20.] 19 p. 4to. n. p. [1886.]

Harvard College Observatory.

ANNALS of the astronomical observatory of Harvard College. Vol. 15, pt. 1. Catalogue of 1,213 stars observed with the meridian circle . . . 1870 to 1879 . . . by W. A. Rogers. 7 + 145 p. 4to. Cambridge, 1886.

——: The same. Vol. 16. Observations of fundamental stars, made with the meridian circle . . . 1870 to 1886 . . . by W. A Rogers. 141 + 337 p. 4°. Cambridge, 1886.

REPORT (41st annual) of the director . . . E. C. Pickering. December 7, 1886. 12 p. 8vo. Cambridge, 1886.

Herschel.

STORY (The) of the Herschels, a family of astronomers. New ed. 128 p. 12mo. London, 1886. .... (M. 1.20)

Holden (Edward Singleton) [1846–].

WINLOCK (W. C.): Sketch of Prof. Edward S. Holden. Pop. Sc. Month., 30: 114–120.

Portrait and bibliography.

Hong-Kong Observatory.

REPORT of the astronomical instruments at the observatory and on the time service at Hong-Kong in 1885. 8 p. fol. Hong-Kong, 1886. .... (M. 1.20)

Huygens (Christian).

LISTE alphabétique de la correspondance de Christian Huygens qui sera publiée par la Société hollandaise des sciences à Harlem. 15 p. 4to. Haag, 1886. (M. 1.80)

Journals (Astronomical).

ASTRONOMICAL (The) Journal. Edited by B. A. Gould. [Semi-monthly.] Vol. 7. Nov., 1886, to Mar., 1888. 6+198 p. 4to. Boston. .... ($5)

Vol. 6 was completed with No. 144, on Feb. 9, 1861. Vol. 7 begins with No. 145, Nov. 2, 1886. Each volume consists of twenty-four numbers.

ASTRONOMICAL (The) Register. [Monthly.] Vol. 24. 8+320 p. 8vo. London, 1886. .... (M. 12.50.)

Discontinued with this volume.

L'ASTRONOMIE. Revue d'astronomie populaire . . . publiée par C. Flammarion. [Monthly.] 5e année, 1886. 492 p. 4to. Paris, 1886. .... (14 fr.)

ASTRONOMISCHE Nachrichten begründet von H. C. Schumacher. Hrsg. von A. Krüger. Bd. 114 [Nr. 2713–2736]. 7+435. 4to. Kiel, 1886. .... (M. 15)

——: The same. Bd. 115 [Nr. 2737–2760]. 7+414 p. 4to. Kiel, 1886. . . (M. 15)

Journals—Continued.

BULLETIN astronomique. Publié sous les auspices de l'Observatoire de Paris, par F. Tisserand [*and others*]. [Monthly.] Tome 3, 1886. 632 p. 8vo. Paris, 1886 ....(M. 16)

BULLETIN des sciences mathématiques et astronomiques, rédigé par Darboux, Houel et Tannery. Année 1886. Série 2. Tome 10. 8°. Paris, 1886..(M. 18)

CIEL et terre. Revue populaire d'astronomie, de météorologie et de physique du globe. [Semi-monthly.] 2e série, 1e année. (6e année de la collection.) 592 p. 8vo. Bruxelles, 1886.

MEMOIRE della Società degli spetroscopisti italiani raccolte e publicate per cura del P. Tacchini. [Monthly.] Vol. 15, anno 1886. 6+208 p. 4to. Roma.

MONTHLY Notices of the Royal Astronomical Society . . . Nov., 1885, to Nov., 1886. Vol. 46. 516 p. 8vo. London, 1886.

OBSERVATORY (The); a monthly review of astronomy. Edited by E. W. Maunder, A. M. W. Downing, and T. Lewis. Vol. 9. 8+404 p. 8vo. London, 1886. (14 sh.)

REVISTA do Observatorio. Publicação mensal do Imperial Observatorio do Rio de Janeiro. Red: L. Cruls [*and others*]. Anno 1, 1886. 8+192 p. 4to. Rio de Janeiro, 1886.

SIDEREAL (The) Messenger; a monthly review of astronomy. Conducted by W. W. Payne. Vol. 5. 320 p. 8vo. Northfield, 1886........................($2)

SIRIUS. Zeitschrift für populäre Astronomie. Hrsg. von H. J. Klein. [Monthly.] 19. Bd. oder N. F. 14. Bd. 4+288 p. 8vo. Leipzig, 1886...............(M. 10)

VIERTELJAHRSSCHRIFT der astronomischen Gesellschaft. Hrsg. von . . . E. Schönfeld und H. Seeliger. 21. Jahrgang. 5+302 p. 8vo. Leipzig, 1886.(M. 8)

WOCHENSCHRIFT für Astronomie, Meteorologie und Geographie. Hrsg. von H. J. Klein. Jahrgang 29. 8vo. Halle, 1886............................(M. 10)

Jupiter. p* 136.

DE BALL (L.): Observations des surfaces de Jupiter et de Vénus faites en 1884 et en 1885 . . . à Liège. Bruxelles, 1886.

DENNING (W. F.): Changes in the red spot on Jupiter. Month. Not., 46: 115–118.

——: Jupiter's red spot, and the region near. il. Obsry., 9: 188.

HILL (G. W.): Elements and perturbations of Jupiter and Saturn. Astron. Nachr., 113: 273–302.

MARTH (A.) Ephemeris for physical observations of Jupiter, 1887. Month. Not., 47: 40–48.

——: Note on the transit of the planet Mars and its satellites across the sun's disc, which will occur for the planet Jupiter and its satellites on April 13, 1886. Month. Not., 46: 161–164.

WILLIAMS (A. S.): Nature of the red spot on Jupiter and the relative heights of Jovian markings. Obsry., 9: 231.

YOUNG (C. A.). Jupiter and his "red spot." Eng. Mechan., 14: 339.

——: Rotation time of the red spot on Jupiter. il. Sid Mess., 5: 289–293.

Jupiter (Satellites of).

CORNU (A.): Sur les méthodes photométriques d'observation des satellites de Jupiter. Astron. Nachr., 114: 239.

DOM LAMEY (F. M.): Dimensions comparatives des satellites de Jupiter, déduites d'observations faites en 1885. Compt. Rend., 102: 1365.

PETERS (C. H. F.): Zur Geschichte photometrischer Beobachtungen der Jupiterstrabanten-Verfinsterungen. Astron. Nachr., 114: 141.

Kalocsa Observatory.

BERICHTE von dem Erzbischoflich Haynald'schen Observatorium zu Kalocsa in Ungarn . . . von C. Braun. 8+178 p. 4to. Münster, 1886.

Rev. by Peter (B.): Vrtljschr. d. astron Gesellsch., 22: 34-45, 1887. *See, also, Ibid.*, 22: 260.

Kann Observatory.

MAURER (J.): Der achtzöllige Refraktor der Kann'schen Privatsternwarte zu Zürich. Sirius, 19: 40–44.

Karlsruhe Observatory.

VERÖFFENTLICHUNGEN der grossherzoglichen Sternwarte zu Karlsruhe. Hrsg. von W. Valentiner. 2. Heft. Beobachtungen am Meridiankreis. 12+213 p. 4to. Karlsruhe, 1886 ....(M. 16)

Kepler. *See, also,* ASTRONOMY (History of).

ANSCHUTZ (C.): Ungedruckte wissenschaftliche Correspondenz zwischen Johann Kepler und H. von Hohenburg, 1599. 118 p. 8vo. Prag, 1886........(M. 2.70)

Rev. Nature, 34: 189.

Kepler's Laws. *See* MECHANICS (Celestial); ORBITS.

Königsberg Observatory.

ASTRONOMISCHE Beobachtungen . . . von E. Luther. 37. Abth. 2. Thiel. 152 p. 4to. Königsberg, 1886 ....(M. 10.70)

La Plata Observatory.

MOUCHEZ (E.): Le nouvel observatoire astronomique de La Plata. Bull. astron., 3: 417–421.

Latitude.

DOOLITTLE (C. L.): [Change in the] latitude of the Sayre Observatory. Astron. Jour., 7: 14.

NYRÉN (M.): Polhöhenbestimmungen mit dem Ertel-Repsold'schen Verticalkreis. 14p. 8vo. St. Petersburg, 1886 ....(M. 0.50)

Least squares.

GAUSS (C. F.): Abhandlungen zur Methode der kleinsten Quadrate. 8vo. Berlin, 1886 ....(M. 4)

Lick Observatory.

COMSTOCK (G. C.): The meridian circle of the Lick Observatory. Sid. Mess., 5: 225–230.

——: Provisional value of the latitude of the Lick Observatory. Sid. Mess., 5: 302–304.

Latitude = + 37° 20′ 24″.9.

EVANS (T.): A Californian's gift to science. il. Century, 32: 62–73.

Light (Velocity of). p* 127.

MICHELSON (A. A.) and MORLEY (E. W.): Influence of motion of the medium on the velocity of light. Am. J. Sc., 3. s., 31 = 131: 377-386.

Rev. by CORNU (A.): Compt. Rend., 102: 1207-1209.

SCHUSTER (A.). Velocity of light determined by Foucault's revolving mirror. Nature, 33: 439.

Louvain Observatory.

PAUWELS (C.): Privatobservatorium des Herrn Terby in Louvain. Sirius, 19: 267.

Lunar theory. p* 133.

ADAMS (J. C.): Hill, on the lunar inequalities due to the ellipticity of the earth. Obsry., 9: 118–120.

FRANZ (J.): Neue Berechnung von Hartwig's Beobachtungen der physischen Libration des Mondes. Astron. Nachr., 116: 1-12.

HALL (A.): [Historical note on] the figure of the earth and the motion of the moon. Annals of Math., 2: 111.

HILL (G. W.): Reply to Mr. Neison's strictures on Delaunay's method of determining the planetary perturbations of the moon. Month. Not., 47: 1-8.

Also, Reprint.

Lunar theory—Continued.

Neison (E.): Delaunay's method for calculating terms of long period in the motion of the moon. Month. Not., 46: 403–439.

Shdanow (A.): Recherches sur le mouvement de la lune autour de la terre d'après la théorie de M. Gyldén. 39 p. 4to. Stockholm, 1885.

Stockwell (J. N.): Inequalities in the moon's motion produced by the oblateness of the earth. Astron. Jour., 7: 4, 17, 25.

von Oppolzer (T.): Entwurf einer Mondtheorie. 37 p. 4to. Wien, 1886..(M. 2)

Repr. from: Denkschr. d. math.-naturwissensch. Kl. d. k. Akad. d. Wissensch. zu Wien, 51.
Rev. by Bruhns (H.): Vrtljschr. d. astron. Gesellsch., 22: 45–50. 1887.

McCormick Observatory.

Publications of the Leander McCormick Observatory of the University of Virginia. Vol. 1, pt. 2. Tail of comet 1882 II. 17 p., 6 pl. 4to. Univ. of Va., 1886.

——: The same. Vol. 1, pt. 3. Nebula of Orion, 1885. 43, p. 6 pl. 4to. Univ. of Va., 1886.

Report of the director . . . June 1, 1886. 3 p. 4to. n. p. [1886.]

McGill College Observatory.

Rogers (W. A.) and McLeod (C. H.): Longitude of the McGill College Observatory. 67 p. 4to. Montreal, 1886.

Repr. from: Trans. Roy. Soc. Canada, 1885.

McKim Observatory.

Appel (D.): Der Refractor des McKim Observatory. il. Ztschr. f. Instrmknd., 6: 15–19.

Mars. p.* 134.

Denning (W. F.): Physical appearance of Mars in 1886. Nature, 34: 104.

Flammarion (C.): La planète Mars. il. L'Astron., 5: 201–206.

Green (N. E.): Northern hemisphere of Mars. Month. Not., 46: 445–447.

Lohse (O.): Ueber die Vortheile der Anwendung eines Kalkspathprismas zur Beobachtung des Mars. Astron. Nachr., 114: 121.

Perrotin (J.): Observations des canaux de Mars. il. Bull. astron., 3: 324–329.

Schiaparelli (A. V.): Osservazioni astronomiche e fisiche sull' asse di rotazione e sulla topografia del pianeta Marte. Memoria III. Opposizione, 1881–'82. 95 p. 4to. Roma, 1886..(M. 8)

Terby (F.): La géographie de la planète Mars. L'Astron., 5: 206.

Wislicenus (W.): Beitrag zur Bestimmung der Rotationszeit des Planeten Mars. 71 p. 4to. Leipzig, 1886 ....(M. 4)

——: Einige Bemerkungen über die Ausdehnung des Schneeflecks am Südpole des Planeten Mars. Astron. Nachr., 114: 57.

Mars (Satellites of).

Hall (A.): [Observations of Deimos, 1886.] Month. Not., 46: 454.

Mechanics (Celestial). *See, also,* Perturbations; Satellites; Series; Three bodies, (Problem of.)

Brinckmann (O.): Bewegung eines materiellen Punctes auf einem Rotations-Paraboloid. 54 p. 8to. Jena, 1886.

Melbourne Observatory.

Observations of the southern nebulæ made with the great Melbourne telescope, from 1869 to 1885. 25 p., 3 pl. 4to. Melbourne, 1885.

Mercury.

Backlund (O.): Sur la masse de la planète Mercure. Bull. astron., 3: 473.

Meridian circle.

Leitzmann (H.): Einflüsse der Wärmevertheilung auf die Theilung des Meridiankreises. 4to. Magdebourg, 1885.

Meridian circle—Continued.

Loewy (M.): Études diverses sur les méthodes d'observation et de réduction. 4to. [Paris, 1886?]

Meteor showers.

Denning (W. F.): [Radiants of] recent showers. Sid. Mess., 5: 309.

——: Radiant point of the Andromedes of Nov. 27, 1885. Andromedes and Leonids in 1965–'66. Astron. Reg., 24: 95–98.

——: The stationary meteor showers. Sid. Mess., 5: 167–173.

Denza (F.): Le stelle cadenti del periodo di Agosto 1885, osservate in Italia. 45 p. 16mo. Torino, 1886.

Förster (W.): Sternschnuppenphänomene vom 27. Nov. 1872 und vom 27. Nov. 1885. Astron. Nachr., 114: 113–119.

Newton (H. A.): The Biela meteors of Nov. 27, 1885. Am. J. Sc., 3. s., 31 = 131: 409–426, 1886.

Schiaparelli (G. V.): Le stelle cadenti: con appendice sulla grande pioggia di stelle cadenti del 27 Nov. 1885. New ed. 8 + 134 p. 16mo. Milano, 1886..(M. 1)

Meteors. p* 125. *See, also,* Comets and Meteors.

Ball (R. S.): L'origine des étoiles filantes. L'Astron., 5: 331–337.

Newton (H. A.) Meteorites, meteors, and shooting stars. Proc. Am. Ass. Adv. Sc., 25: 1–18. *Also,* Reprint. *Also:* Science, 8: 169–176. *Also:* Nature, 34: 532–536.

Address as retiring president of the American Association, Buffalo, August 18, 1886.

Zenger (C.-V.): Les essaims périodiques d'étoiles filantes et les mouvements seismiques des années 1883, 1884 et 1885. Compt. Rend., 103: 1287–1289.

——: Les principaux essaims d 'étoiles filantes et les aurores boréales. Compt. Rend., 103: 738–741.

Meteors (Orbits of, etc.).

Backhouse (T. W.): Proposed maps for tracing meteor paths. Astron. Nachr., 114: 19.

Buszczynski (B.): Ueber die Bahnen der am 11. Dezember 1852 und am 3. Dezember 1861 in Deutschland beobachteten hellen Meteore. 32 p. 8vo. Halle, 1886.

Corrigan (S. J.): Relation between meteoric orbits and radiants. Sid. Mess., 5: 100–105.

Denning (W. F.): Distribution of meteor streams. Month. Not., 47: 35–39.

Jesse (O.): Bestimmung der Höhe der Sternschnuppen in bekannten Bahnen durch Beobachtungen von einem Orte aus. Astron. Nachr., 114: 145.

Monck (W. H. S.): Trained meteors. Obsry., 9: 131.

Wendell (O. C.): Orbits of meteors. Astron. Nachr., 114: 285.

Weyer (G. D. E.): Elementare Berechnung der Sternschnuppenbahnen um die Sonne. Astron. Nachr., 115: 113–132.

Moon. p* 133. *See,* also, Lunar theory.

Abetti (A.): Tavole per vidurre il nascere ed il tramontare della luna dalle effemeridi di Berlino agli orizzonti di latitudini fra 36 e 48 gr. 12 p. [Venezia]. 1886 ....(M. 1)

Ericsson (J.): The lunar surface and its temperature. il. Nature, 34: 248.

de Fonvielle (W.): Histoire de la lune. il. 8°. Paris, 1886 ....(M. 2)

Harley (T.): Lunar science, ancient and modern. 8vo. London, 1886..(M. 3.70)

Mellor (T. K.): Handy map of the moon, 13 by 15 inches. London, 1886. (3 *sh.* 6*d.*)

Proctor (R. A.): The moon: her motions, aspect, scenery, and physical conditions. 3. ed. 314 p. il. 8vo. London, 1886 ....(M. 6. 50)

Moon—Continued.

Saporetti (A.): Metodo universale per iscoprire spediamente gl' istanti de nascere e del tramontare della luna in qualsiasi luogo d 'Italia. 13 p. 4to. Bologna, 1886.

Weinek (L.): Zeichnungen von Mondkratern und Mondlandschaften. Astron. Beob. zu Prag. App. zum 45. Jahrg., p. 59–69.

Moscow Observatory.

Annales de l'Observatoire de Moscou. Publiées par T. Bredichin. Série 2, v. 1, livraison 1. 118 p., 2 pl. 4to. Moscou, 1886........................(M. 6)

Natal Observatory.

Report of the superintendent . . . 1885. 30 p. 4to. n. p. [1886.]

Nebulæ. p* 101. *See, also,* Pleiades.

von Gothard (E.): [Photographing a faint star in the Ring nebula in Lyra.] Astron. Nachr., 115: 221, 303.

Stone (O.): List of nebulas observed at the Leander McCormick Observatory and supposed to be new. Astron. Jour., 7: 9–14.

——: The same. Second list. Astron. Jour., 7: 57–61.

Stone (O.) and Leavenworth (F. P.): [Observations of the] Nebula of Orion, 1885. 43 p., 3 pl. 4to. Univ. of Va., 1886.

Pub. McCormick Obsry., v. 1, pt. 3.

Swift (L.): Catalogue No. 3 of nebulæ discovered at the Warner Observatory. Astron. Nachr., 115: 153–158.

——: The same. No. 4. Astron. Nachr., 115: 257–262.

——: The same. No. 5. Astron. Nachr., 116: 33–38.

Tempel (W.) Ueber Nebelflecken . . . 1876–'79 . . . zu Arcetri. 28 p. 4to. Prag, 1886 ....(M. 3)

Neptune (Satellite of). p* 139.

Marth (A.): Ephemeris of the satellite of Neptune. Month. Not., 46: 504–507.

Neuchâtel Observatory.

Rapport du directeur . . . 1885. 32 + 27 p. 12mo. Locle, 1886.

Nutation. p* 103.

Folie (F.): Démonstration pratique de l'existence de la nutation diurne. Compt. Rend., 103: 1171–1173.

Objectives. *See, also,* Spherometer.

Berger (C. L.): Apparat zur genauen Bestimmung der Brennweite von Objectivgläsern. il. Ztschr. f. Instrmknd., 6: 272–276.

Harzer (P.): Ueber ein dreiflachiges nach Herrn Scheibner's Principien berechnetes Objectiv. Astron. Nachr., 115: 241–252.

Laurent (L.): Sur l'exécution des objectifs pour instruments de précision. Compt. Rend., 102: 545–548.

Schröder (H.): Ueber die den bekannten Doppelobjectiven anhaftenden Uebelstände und eine neue davon freie Linsencombination für grosse Refractoren. Ztschr. f. Instrmknd., 6: 41–46.

Observations (Combination of). *See, also,* Least squares.

Newcomb (S.): A generalized theory of the combination of observations, so as to obtain the best result. Am. J. Math., 8: 343–366.

Rev. by Lüroth (J.): Vrtljschr. d. astron. Gesellsch., 21: 272–276.

Rev. Obsry., 9: 370.

Observatories. p* 139.

Jahresberichte der Sternwarte für 1885. Vrtljschr. d. astron. Gesellsch., 21: 69–150.

Lancaster (A.): Liste générale des observatoires et des astronomes, des sociétés et des revues astronomiques. 114 p. 12mo. Bruxelles, 1886........(M. 1.50)

Occultations.

Woodside (C. L.): Short method for computing occultations. il. Sid. Mess., 5: 203–210.

Orbits. *See, also,* Three bodies (Problem of).

Andoyer (H.): Contribution à la théorie des orbites intermédiaires. 72 p. 4to. Paris, 1886 .... (3 fr. 50c.)

Bryant (R.): Kepler's problem. Month. Not., 47: 8–14.

Gyldén (H.): Intermediära banor, som vid en gifven tidpunkt ansluta sig till de verkliga med en kontakt of tredja ordningen. 20 p. 8vo. Stockholm, 1886.

Israel-Holtzwart (K.): Elemente der theoretischen Astronomie. il. 8vo. Wiesbaden, 1886 .... (M. 25)

Neumann (C.): Ausdehnung der Kepler'schen Gesetze auf den Fall, dass die Bewegung auf einer Kugelfläche stattfindet. Ber. ü. d. Verhandl. d. k. sächs. Gesellsch. d. Wissensch. Leipz. Math.-phys. Cl., 1886.

von Oppolzer (T.) Traité de la détermination des orbites des comètes et des planètes . . . Édition française, publiée d'après la deuxième édition allemande par Ernest Pasquier. Premier volume. 26 + 491 + 209 p. 4to. Paris, 1886. (30 fr.)

Thurein (H.): Elementare Darstellung der Planetenbahnen durch Konstruktion und Rechnung. 34 p. 8vo. Berlin, 1886 .... (M. 1)

Padua Observatory.

Abetti (A.): Esperimento per le determinazioni di latitudine . . . all' Osservatorio di Padova nell' ottobre 1885. 6 p. 8vo. Roma, 1886 .... (M. 1)

——: Osservazioni astronomiche fatte all' Osservatorio di Padova coll' equatoriale Dembowski nel 1886. 11 p. 8vo. Venezia, 1886 .... (M. 0.60)

Parallax (Stellar). p. 108.

Hall (A.): Observations for stellar parallax [of α Lyræ, 61 Cygni, 40 (o^2) Eridani, and 6 B Cygni]. 67 p. 4to. Washington, 1886.
Wash. Obsn's., 1883, App. II.

Schur (W.): Bestimmung der Parallaxe des Doppelsterns ψ^5 Aurigæ. Astron. Nachr., 114: 161.

Paris Observatory.

Périgaud (E.-L.-A.): Erreurs de division du cercle de Gambey. Compt. Rend., 103: 591–594.

Rapport annuel sur l'état de l'Observatoire de Paris pour l'année 1885, présenté au conseil . . . 22 janvier 1886. 28 p., 1 pl. 4to. Paris, 1886.

Pendulum.

Lorentzen (G.): Theorie des Gaussischen Pendels. Astron. Nachr., 114: 241–284.

Personal equation.

Seeliger (H.): Einfluss dioptrischer Fehler des Auges auf das Resultat astronomischer Messungen. Abhandl. d. math.-phys. Cl. d. k. bayer. Ak. d. Wissensch., 15: 665–704.

Perturbations.

Callandreau (O.): Simplifications qui se présentent dans le calcul numérique des perturbations pour certaines valeurs de l'argument. Compt. Rend., 102: 598–601.

Radau (R.): Sur quelques formules de la théorie des perturbations. Bull. astron., 3: 433, 475.

Tisserand (F.): Sur un cas remarquable du problème des perturbations. Bull. astron., 3: 425–433. *Also:* Compt. Rend., 103: 446–451.

Photography (Astronomical). p*115. *See, also,* NEBULÆ; *Photography* (Solar), PLEIADES; etc.; SPECTRA (Stellar).

EDER (J. M.): Die Moment-Photographie in ihrer Anwendung auf Kunst und Wissenschaft. 8+198 p. Il. 8vo. Halle, 1886 ....(M. 24)

VON GOTHARD (E.): Apparate für Aufnahme himmlischer Objecte. Ztschr. f. Instrmknd, 6: 5–14. *Also*, Reprint.

HOLDEN (E. S.): Photography, the servant of astronomy. Overland Month., 2. s., 8: 459–470.

STEIN (S. T.): Die Photographie im Dienste der Astronomie, Meteorologie und Physik. il. 8vo. Halle, 1886......................................(M. 5)

STONE (O.): Photographers *versus* old-fashioned astronomers. Sid. Mess., 6: 1–4.

STRUVE (O.): Die Photographie im Dienste der Astronomie. 20 p. 8vo. St. Petersburg, 1886..(M. 1)

Repr. from: Mél. math. et astron. tirés du Bull. de l'Acad. d. sc. St. Péterab. 6: 493–517.

TRAMBLAY (G.): Photographie lunaire dans les instruments de moyenne puissance. L'Astron., 5: 382–384, 425.

Photography (Solar).

HUGGINS (W.): Photography of the solar corona. Science, 8: 303. *Also:* Nature, 34: 469. *Also:* Astron. Nachr., 115: 191.

Photography (Stellar).

COMMON (A. A.): Photography as an aid to astronomy. Eng. Mechan., 43: 453–455.

FLAMMARION (C.): La photographie céleste à l'Observatoire de Paris. il. L'Astron., 5: 42–57.

——: Comparaison des résultats de l'observation astronomique avec ceux de la photographie. L'Astron., 5: 188

GILL (D.): Photographie astronomique. Bull. astron., 3: 161–164.

VON GOTHARD (E.): Anwendung der Photographie zu Meridian-Beobachtungen. Astron. Nachr., 115: 315.

——: Photographische Aufnahmen. Astron. Nachr., 115: 221.

GOULD (B. A.): Photographic determinations of stellar positions. Proc. Am. Ass. Adv. Sc., 35: 74–79. *Also:* Am. J. Sc., 3. s., 32 = 132: 369–375.

HENRY (Paul) and HENRY (Prosper): Astronomical photography. il. Nature, 34: 35–37.

—— ——: Étoiles doubles et amas d'étoiles mesurés par la photographie. il. L'Astron., 5: 281–286.

JANSSEN (J.) Note sur la constitution des taches solaires et sur la photographie envisagée comme instrument de découvertes en astronomie. Compt Rend., 102: 80–82.

LOHSE (O.): Ueber Stellar-Photographie. Astron. Nachr., 115: 1–14.

MOUCHEZ (E.): Photographies astronomiques de MM. Paul Henry et Prosper Henry. Compt. Rend., 102: 148, 289.

PICKERING (E. C.): Draper memorial photographs . . . [etc.]. Nature, 34: 439.

——: Investigation (An) in stellar photography, conducted at the Harvard College observatory. Mem. Am. Acad. Arts, etc., 11: 179–226, 1886.

Also: Reprint, with appendix.

PRITCHARD (C.): Remarkable instance of the detection of distortion in a photographic film measured for the purpose of stellar parallax. Month. Not., 46: 442–444.

——: Researches in stellar photography. Proc. Roy. Soc., Lond., 41: 195–212.

Also [Abstr.]: Nature, 34: 305.

RANYARD (A. C.): Connection between photographic action, the brightness of the luminous object, and the time of exposure as applied to celestial photography. Month. Not., 46: 305–309.

Photography (Stellar)—Continued.

ROBERTS (I.): Note on photographs of stars in Cygnus, taken in August, 1886. Month. Not., 47 : 22.

——: Photographic maps of the stars. Month. Not., 46 : 99–103.

WOLF (C.): Comparaison des résultats de l'observation astronomique directe avec ceux de l'inscription photographique. Compt. Rend., 102 : 476.

ZENGER (C. V.): Études phosphorographiques pour la reproduction photographique du ciel. Compt. Rend., 102 : 408–410.

Photometry. p.*112.

CHANDLER (S. C.), jr. Comparative (A) estimate of methods and results in stellar photometry. [*Abstr.*] Proc. Am. Ass. Adv. Sc., 35 : 81.

——: Light-ratio unit of stellar magnitudes. Astron. Nachr., 115 : 145–154.

PRITCHARD (C.): Supplementary measures of the magnitudes of a zone of stars near the equator for reference as standards of magnitude in lieu of Polaris. Month. Not., 46 : 439–442.

SAWYER (E. F.): Some account of a new catalogue of the magnitudes of southern stars. Proc. Am. Ass. Adv. Sc., 35 : 80. *Also:* Sid. Mess., 5 : 299–302.

SEELIGER (H.): Bemerkungen zu Zöllner's "Photometrischen Untersuchungen." Vrtljschr. d. astron. Gesellsch., 21 : 216–229.

Planets. p*133.

CHRISTIANSEN (C.): Bemerkungen über die Temperatur der Planeten. Sirius, 19 : 256–258.

Planets (Minor). *See* ASTEROIDS.

Pleiades. p*101.

CLERKE (A. M.): [History of] the Pleiades. Nature, 33 : 561–564.

COMMON (A. A.): Nebulæ in the Pleiades. Month. Not., 46 : 341.

FLAMMARION (C.): Comparaison des résultats de l'observation astronomique avec ceux de photographie. Compt. Rend., 102 : 911–914.

HENRY (P.): The photographic nebulæ in the Pleiades. Month. Not., 46 : 281.

HENRY (Paul) and HENRY (Prosper): Sur une carte photographique du groupe des Pléiades. Compt. Rend., 102 : 848–851.

KAMMERMANN (A.): Ueber den Majanebel. Astron. Nachr., 114 : 313.

PERROTIN (J.): Observation de la nébuleuse de Maïa. Compt. Rend., 102 : 544.

ROBERTS (I.): Note on two photographs of the nebulæ in the Pleiades, taken in October, 1886. Month. Not., 47 : 24.

STRUVE (O.): Ueber den Majanebel. il. Astron. Nachr., 114 : 97.

WEISS (E.): Ueber die Nebel in den Plejaden. il. Astron. Nachr., 114 : 209.

WOLF (C.): Comparaison des résultats de l'observation astronomique directe avec ceux de l'inscription photographique. Compt. Rend., 102 : 476.

Potsdam Observatory.

PUBLICATIONEN des astrophysikalischen Observatoriums zu Potsdam. Hrsg. von H. C. Vogel. 5. Bd., 7 + 281 p. 4to. Leipzig, 1886.

Prague Observatory.

ASTRONOMISCHE Beobachtungen an der k. k. Sternwarte zu Prag im Jahre 1884, von L. Weinek. App. zum 45. Jahrgang. 74 p., 4 pl. 4to. Prag, 1886.

Rev. by SCH[ÖNFELD]: Vrtljschr. d. astron. Gesellsch., 21 : 46–50.

Precession.

FLAMMARION (C.): Le mouvement séculaire du pôle et la transmission du système solaire. il. L'Astron., 5, 401–406.

ROGERS (W. A.) and WINLOCK (A.): Reduction of the positions of close circumpolar stars from one epoch to another. Mem. Am. Acad. Arts and Sc., 11 : 227–299, 1886. *Also* Reprint.

Precession—Continued.

Weiss (E.): Ueber die Berechnung der Präcession mit besonderer Rücksicht auf die Reduction eines Sterncataloges auf eine andere Epoche. 28 p. 4to. Wien, 1886 .... (M. 1.50)

Repr. from: Denkschr. d. k. Akad. d. Wissensch. Math-naturwis, Cl. Wien, 53: 53–80.

Prominences (Solar). *See, also,* Sun; Sun-spots.

Tacchini (P.): Résultats fournis par l'observation des protubérances solaires pendant l'année 1885. Compt. Rend., 102: 457.

Trouvelot (E. L.): Changements temporaires de réfrangibilité des raies du spectre de la chromosphère et des protubérances solaires. Bull. astron., 3: 9–22.

——: Protuberances visible on the spectrum with a narrow slit. Month. Not., 46: 331–333.

Rev. by Maunder (E. W.): Month. Not., 46: 334.

Wild (H.): Relations entre les variations du magnétisme terrestre et les phénomènes observés sur le soleil. Compt. Rend., 102: 508.

Pulkowa Observatory.

Jahresbericht am 25 Mai, 1886 . . . [etc.] 52 p. 8vo. St. Petersburg, 1886.

Untersuchung der Repsold'schen Theilung des Pulkowaer Verticalkreises. 37 p. 4to. St. Petersburg, 1886 .... (M. 1)

Mém. Acad. imp. d. sc. de St.-Pétersb., 7. sér., vol. 34, No. 2.

Radcliffe Observatory.

Results of astronomical and meteorological observations made in the year 1883. Vol. 41. 8vo. Oxford, 1886.

Reflectors. *See, also,* Telescopes.

Spitta (E. J.): Method of collimating Newtonian reflectors. Obsry., 9: 349–351.

Refraction.

Abbe (C.): A correction for gravity in the use of refraction tables. Astron. Nachr., 116: 15.

Gaillot (A.): Détermination de l'erreur de la constante de la réfraction astronomique par les observations méridiennes. Compt. Rend., 102: 200, 247.

Gill (D.): Some suggested improvements in the practical working of M. Loewy's new method of astronomical refraction. Month. Not., 46: 326–328. *Also, trans.:* Compt. Rend., 102: 732–735.

Loewy (M.): Nouvelle méthode pour la détermination des éléments de la réfraction. Compt. Rend., 102: 74–80.

——: Détermination des éléments de la réfraction. Compt. Rend., 102: 290–297.

——: Détermination des éléments de la réfraction. Examen des conditions générales à remplir dans la solution pratique du problème. Compt. Rend., 102: 380–385.

——: Détermination des éléments de la réfraction. Solution pratique la plus favorable. Compt. Rend., 102: 533–539.

——: Nouvelles méthodes pour la détermination directe de la valeur absolue de la réfraction à divers degrés de hauteur. Compt. Rend., 102: 887–894.

——: Nouvelle méthode générale pour la détermination directe de la valeur absolue de la réfraction à tous les degrés de hauteur. Compt. Rend., 102: 1196–1202.

——: Nouvelle méthode pour déterminer les réfractions à toutes les hauteurs à l'aide de la valeur connue d'une seule. Compt. Rend., 102: 1273–1279.

McNeill (M.): Logarithmic method of correcting for differential refraction in declination. Astron. Nachr., 114: 385–390.

von Oppolzer (T.): Ueber die astronomische Refraction. 52 p. tab. 4to. Wien, 1886 .... (M. 2.60)

Pickering (E. C.): Atmospheric refraction. Proc. Am. Acad. Arts and Sc., 21: 268–302, 1886.

Rio Janeiro Observatory.

CRULS (L.): Sur le transfert de l'Observatoire impérial de Rio de Janeiro. Compt. Rend., 103: 548.

Rome Observatory.

MILLOSEVICH (E.): Determinazione della latitudine del R. Osservatorio del Collegio Romano. 68 p. 4to. Roma, 1886.

In: Ann. de Meteor. Ital., pt. 3, 1885.

Satellites.

DARWIN (G. H.): Tidal friction and the evolution of a satellite. Nature, 33: 367.

NOLAN (J.): Tidal friction and the evolution of a satellite. Nature, 34: 286; 35: 75.

Saturn. p* 137.

BATTERMANN (H.): Heliometrischer Auschluss des Saturn an μ und η Germinorum [Jan. and Mar., 1886]. Astron. Nachr., 115: 225–230.

HILL (G. W.): Elements and perturbations of Jupiter and Saturn. Astron. Nachr., 113: 273–302.

Saturn (Satellites of).

HALL (A.): Comparison of the observations of the five inner satellites of Saturn, made at Toulouse in 1876 and 1877. Astron. Nachr., 115: 97–104.

——: [Orbits of] the six inner satellites of Saturn. 74 p. 4to. Washington, 1886.

Wash. Obsns., 1883, App. 1.

MARTH (A.): Ephemerides of the satellites of Saturn [1886–'87]. Month. Not. 46: 469–486.

TISSERAND (F.): Sur un cas remarquable du problème des perturbations. Compt. Rend., 103: 446–451. *Also:* Bull. astron., 3: 425–433.

Sayre Observatory.

DOOLITTLE (C. L.): [Change in the] latitude of the Sayre Observatory. Astron. Jour., 7: 14.

Seasons.

PROCTOR (R. A.): The seasons pictured in 48 sun-views of the earth, and 24 zodiacal maps, and other drawings. 4to. London, 1885 ....(M. 5.30)

Series. *See, also,* MECHANICS (Celestial); PERTURBATIONS.

CALLANDREAU (O.): Développement des coordonnées elliptiques. Bull. astron., 3: 528–532.

CHARLIER (C.-V.-L.): Méthode permettant d'augmenter la convergence des séries trigonométriques. Bull. astron., 3: 378–385.

POINCARÉ (H.): Moyen d'augmenter la convergence des séries trigonométriques. Bull. astron., 3: 521–528.

Sextant.

DREYER (J. L. E.): On the invention of the sextant. Astron. Nachr., 115: 33.

GRUEY (L.-J.): Sur les constantes du grand miroir du sextant. Bull. astron. 3: 5–9.

Sky-glows.

BISHOP (S.): Origin of the red glows. Sid. Mess., 5: 129–142.

MAINE (H. C.): The "red light." il. Sid. Mess., 5: 237–251.

NEWCOMB (S.): Red sunsets and volcanic eruptions. Nature, 34: 340.

RICCÒ (A.): L'île Ferdinandea, le soleil bleu et les crépuscules rouges de 1831. Compt. Rend., 102: 1060–1063.

——: Red sunsets and volcanic eruptions. Nature, 34: 386.

Solar system.

FÖRSTER (A.): Eine durch eigenthümliche Beziehungen zwischen Planetenentfernungen und Planetenmassen veranlasste neue Hypothese der Entwicklung des Sonnensystems. 2+16 p. 8vo. Stuttgart, 1886 ....(M. 0.50)

Solar system—Continued.

Kerr (F.): Entstehung der Körper, welche sich um die Sonne bewegen. 79 p. 8vo. Leipzig, 1886 ....(M. 1. 80)

Turner (H. H.): Note on Mr. Marth's "intersects." il. Month. Not., 46: 157.

Vail (J. N.): The earth's annular system. 400 p. 12mo. Cleveland, 1886. (M. 10)

Solar system (Motion of). p* 126. *See, also,* Stars (Motion of).

Flammarion (C.): Le point fixe dans l'univers. L'Astron., 5: 241-251.

Folie (F.): Note sur le mouvement du système solaire. Astron. Nachr., 114: 355.

Homann (H.): Bestimmung der Bewegung des Sonnensystems durch Spectral-Messungen. Astron. Nachr., 114: 25.

von Kövesligethy (R.): Bestimmung der Bewegung des Sonnensystems durch Spectral-Messungen. Astron. Nachr., 114: 327.

Spectra (Stellar). p* 113.

Pickering (E. C.): Draper memorial photographs of stellar spectra, exhibiting bright lines. Nature, 34: 439, 570.

Sherman (O. T.): Reply to certain questions raised before the Royal Astronomical Society . . . [etc.]. Month. Not., 47: 14-18.

Spectroscope.

Hasselberg (B.): Anwendung von Schwefelkohlenstoff-Prismen zu spectroscopischen Beobachtungen von hoher Präcision. 8vo. Leipzig, 1886.

Zenger (K. W.): Neues geradsichtiges Spectroscop ohne Spalt und ohne Collimatorlinse. Ztschr. f. Instrmknd., 6: 59.

Spectrum analysis.

Janssen (J.): Spectres d'absorption de l'oxygène. Compt. Rend., 102: 1352.

Langley (S. P.): Experimental determination of wave-lengths in the invisible prismatic spectrum. Mem. Natl. Acad. Sc., 2: 149-162, 1885. 4 pl.

——: Observations on invisible heat spectra and the recognition of unmeasured wave-lengths, made at the Allegheny Observatory. Phil. Mag., 5. s., 21: 394-409.

——: On hitherto unrecognized wave-lengths. Am. J. Sc., 3. s., 32 = 132: 83-106. 4 pl.

——: Sur des longueurs d'onde jusqu'ici non reconnues. Compt. Rend., 102: 162-164.

Smyth (C. Piazzi): Micrometrical measures of gaseous spectra under high dispersion. Trans. Roy. Soc. Edinb., 32: 415-480. 30 pl. 1886. *Also,* Reprint.

Spectrum (Solar). p* 126.

Cornu (A.): Étude des bandes telluriques *a*, *B*, et *A* du spectre solaire. 105 p. 8vo. Paris, 1886 ....(M. 2.50)

Hasselberg (B.): Méthode propre à déterminer avec grande précision les longueurs d'onde des raies ultra-violettes du spectre solaire. Mem. Soc. spettrosc. ital., 15: 127-133.

Müller (G.) and Kempf (P.): Bestimmung der Wellenlängen von 300 Linien im Sonnenspectrum. 4to. Leipzig, 1886 ....(M. 12)
In. Pub. astrophys. Obs. zu Potsdam, Bd. 5.

—— ——: Neuberechnung der 2,614 in Publication Nr. 3 des astrophysicalischen Observatoriums zu Potsdam bestimmten Wellenlängen. 4to. Leipzig, 1886 ....(M. 1)

Pickering (E. C.): Comparison of maps of the ultra-violet spectrum. Am. J. Sc., 132: 223-226.

Spherometer.

Mayer (A. M.): On the well-spherometer, an instrument that measures the radius of curvature of a lens of any linear aperture. il. Am. J. Sc., 3. s., 32 = 132: 61-69.

Star-catalogues. p* 104.

Armagh (2d) catalogue of 3,300 stars for the epoch 1875, from observations . . . 1859 to 1883, under the direction of . . . T. R. Robinson, . . . prepared for publication by J. L. E. Dreyer. 15+159 p. 8vo. Dublin, 1886.

Auwers (A.): Bemerkung über die gegenwärtige Verlässlichkeit des Fundamental-Catalogs für die Zonen-Beobachtungen der astronomischen Gesellschaft und die Genauigkeit seiner Grundlagen. Astron. Nachr., 114 : 1–20.

Downing (A. M. W.) Comparison of certain southern star-catalogues. Month. Not., 46 : 365–379.

Farquhar (H.): Comparison of the Boss and Auwers declination-standards. Proc. Am. Ass. Adv. Sc., 35 : 82.

Gould (B. A.): The Argentine general catalogue. Mean positions of [32,448] southern stars [for 1875.0] determined at the National Observatory. 15+650 p. 4to. Córdoba, 1886.
Resultados d. Obs. nac. Argentino, vol. 14.

Holden (E. S.): Corrections to the star-catalogues in the library of the Washburn Observatory. Pub. Washb. Obsry., 4: 69–76.

Kam (N. M.): Catalog von Sternen deren Örter durch selbstständige Meridian-Beobachtungen bestimmt worden sind, aus Bd. 1 bis 66 der Astron. Nachr., reducirt auf 1855.0. 22+384 p. 4to. Amsterdam, 1886..............(M. 16)
Verhandl. d. k. Akad. d. Wetensch., deel 24.

Pulkowa. Positions moyennes de 3,542 étoiles déterminées à l'aide du cercle méridien . . . 1840–1869, et réduites à l'époque 1855.0.
Repr. from Obsns. d. Poulkova, tome 8.

Romberg (H.): Genäherte Örter der Fixsterne von welchen in den Astronomischen Nachrichten Bd. 67 bis 112 selbstständige Beobachtungen angeführt sind für die Epoche 1855. 52 p. 4to. Leipzig, 1886......................(M. 4)
Pub. d. astron. Gesellsch., 18.

Safford (T. H.): Comparison of Groombridge's and Struve's right ascensions of close circumpolar stars. Month. Not., 46 : 37.

Schönfeld (E.): Bonner Sternverzeichniss. Vierte section, enthaltend die genäherten mittleren Örter für den Anfang des Jahres 1855 von 133,659 Sternen zwischen 2 und 23 Grad südlicher Declination und 1,173 diesen Grenzen benachbarten . . . beobachtet und berechnet von Eduard Schönfeld. 56 + 459 p. 4to. Bonn, 1886..(M. 20)
Astron. Beob. zu Bonn., Bd. 8.

Weiss (E.): Berichtigungen zu Öltzen's Catalog der Argelander'schen südlichen Zonen, nebst Mittheilung von einigen südlichen Sternen mit ziemlich starker Eigenbewegung. Astron. Nachr., 115 : 313.

Star-charts.

Colbert (E.): The fixed stars; maps for out-door study. Chicago, 1886.

Klein (H. J.): Stern-Atlas enthaltend sämmtliche Sterne 1–6.5 Grösse zwischen dem Nordpol und 34 Grad südlicher Declination. 40 p., 18 maps. fol. Leipzig, 1886.
10 Lfgn. Jede Lfg. M. 1.20.

Peck (W.): The southern hemisphere constellations, and how to find them. 13 maps. 4to. London, 1885.......................................(M. 3.80)

Schönfeld (E.): Bonner Sternkarten. 2. Serie. Atlas der Himmelszone zwischen 1° und 23° südlicher Declination für den Anfang des Jahres 1885. i und ii Lfgn. 4 p., 12 maps. fol. Bonn, [1886].
Vollständig in 4 Lfgn. 24 Sternkarten. Jede Lfgn. M 12.

Proctor (R.-A.): Nouvel atlas céleste . . . [etc.]. Trad. sur la 6. éd. anglaise par P. Gerigny. 13 + 98 p. 8vo. Paris, 1886.....................(M. 5.20)

Schurig (R.): Tabulæ cælestes continentes omnes stellas cæli borealis nec non australis nudis oculis conspicuas. 2 p., 8 maps. fol. Leipzig, 1886 ....(M. 3)

Star-clusters.

Schultz (H.): Mikrometrische Bestimmung einiger teleskopischen Sternhaufen. 43 p., 3 pl. 8vo. Stockholm, 1886.

Bihang till k. Svenska Vet. Akad. Handlingar, Bd. 12, Afd. 1, No. 2.

Stars (Circumpolar, Reduction of).

Gruey (L.-J.): Sur les formules de M. Loewy pour la réduction des circompolaires. Compt. Rend, 102: 966–969.

Rogers (W. A.) and Winlock (A.): [Reduction of the positions of close polar stars from one epoch to another.] Mem. Am. Acad. Arts and Sc., vol. 11, pt. 4, no. 5, p. 227–299. 1886. *Also*, Reprint.

Stars (Distribution of). p*99.

Seeliger (H.): Die Vertheilung der Sterne auf der südlichen Halbkugel nach Schönfeld's Durchmusterung. 24 p. 8vo. München, 1886 ....(M. 1.20)

In: Sitzungsb. d. k.-bayer. Akad. d. Wissensch., Math.-phys. Cl., München, 1886, Heft 2.

Stars (Motion of) in line of sight. *See, also,* Solar system (Motion of).

Christie (W. H.): Spectroscopic results for the motions of stars in the line of sight, obtained at . . . Greenwich, in 1885. Month. Not., 46: 126–135.

Homann (H.): Beiträge zur Untersuchung der Sternbewegung und der Lichtbewegung durch Spectralmessungen. 28 p. 8vo. Berlin, 1885.

Stars (Number of)

Hermite (G.): Détermination du nombre des étoiles de notre univers. L'Astron., 5: 406.

Stockholm Observatory.

Astronomiska Jakttagelser och Undersökningar anstalda pa Stockholms Observatorium. Bd. III, No. 4. 4to. Stockholm, 1886.

Strasburg Observatory.

Schur (W.) Fernerer Bericht über die Thätigkeit der Strassburger Sternwarte. Astron. Nachr., 114: 401–404.

Sun. p*126. *See, also,* Corona; Prominences; Spectrum.

Ångström (K.): Nouvelle méthode de faire des mesures absolues de la chaleur rayonnante ainsi qu'un instrument pour enregistrer la radiation solaire. 17 p., 1 pl. 4to. Upsala, 1886.

Belopolsky (A.): Einige Gedanken über die Bewegungen auf der Sonnenoberfläche. Astron. Nachr., 114: 153, 383.

Exner (F.): Zur Photometrie der Sonne. 12. p. 8vo. Wien, 1886....(M. 0.30)

Repr. from: Sitzungsb. d. Math-naturwissen. Cl. d. k. Akad. d. Wissensch. Wien. 94 (2 Abth.) 345-56.

Kedzie (J. H.): Speculations: Solar heat, gravitation, and sun-spots. 12 + 304 p. 12mo. Chicago, 1886.

Lockyer (J. N.): The data now requisite in solar inquiries. Science, 7: 386.

Maurer (J.): Langley's Bestimmungen über das Maass der Sonnenstrahlung mit Violle's Aktinometer. Ztschr. f. Instrmknd., 6: 237–243.

Young (C. A.): Recent advances in solar astronomy. Pop. Sc. Month., 30: 24–33.

Zenger (K. W.): Die Meteorologie der Sonne und ihres Systemes. 22 + 231 p. il. 8vo. Wien, 1886..(M. 5)

Sun (Diameter of).

Auwers (A.): Neue Untersuchungen über den Durchmesser der Sonne, I. Sitzungsb. d. k-preuss. Akad. d Wissensch. Berlin, 1886: 1055–1126. *Also*, Reprint.

Sun-spots.

Belopolsky (A.): Пятна на солнцѣ и ихъ движеніе. Москва, 1886. [Les taches solaires et leur mouvement. 184 p., 7 pl. 8vo. Moscow, 1886.]

Chambers (F.): Sun-spots and prices of Indian food grains. Nature, 34: 100–104.

Sun-spots—Continued.

CORTIE (A.): Bands observed in the spectra of sun-spots at Stonyhurst Observatory. Month. Not., 47: 19–22.

DELAUNEY (J.): Explication des taches du soleil. 13 p. 8vo. Paris, 1886.
Also [Abstr.]: Compt. Rend., 103, 566–569.

DREGER (H.): Darstellung der verschiedenen Theorien der Sonnenflecken. 26 p. 8vo. Berlin, 1886 .... (M. 0.60)

FLAMMARION (C.): Les taches solaires, la température et le prix du blé. L'Astron., 5: 454–461.

GERIGNY (P.): Les taches solaires en 1885. L'Astron., 5: 208–215.

HOWLETT (F.): Asserted foreshortening of the inner side of the penumbra of spots when near the sun's limb. Month. Not., 46: 447–451.

JANSSEN (J.): Constitution des taches solaires . . . [etc.]. Compt. Rend., 102: 80–82.

SPÖRER (A.): Ueber die jetzige Sonnenflecken-Periode. Astron. Nachr., 114: 21.

TACCHINI (P.): Distribution en latitude des phénomènes solaires pendant l'année 1885. Compt. Rend., 102: 601.

WESEN der Sonnenflecken. Sirius, 19: 150–154.

WOLF (R.): Vorläufige Sonnenflecken-Statistik für 1885. Astron. Nachr., 114: 21.

——: Beobachtungen der Sonnenflecken im Jahre 1884 . . . [etc.]. Vrtljschr. d. naturforsch. Gesellsch. in Zürich, 30: 1–54. 1885.
Astron. Mittheil., 64.

——: Studie über die . . . Erfahrungsfactoren . . . [etc.]. Vrtljschr. d. naturforsch. Gesellsch. in Zürich, 30: 230–256. 1885.
Astron. Mittheil., 65.

——: Mittheilung eines Ergebnisses meiner einheitlichen Variationsreihe . . . [etc.]. Vrtljschr. d. naturforsch. Gesellsch. in Zürich, 30: 321–326. 1885.
Astron. Mittheil., 66.

——: Beobachtungen der Sonnenflecken im Jahre 1885 . . . [etc.]. Vrtljschr. d. naturforsch. Gesellsch. in Zürich, 31: 113–160.
Astron. Mittheil., 67.

WOLFER (A.): Heliographische Örter von Sonnenflecken im Jahre 1884. Astron. Nachr., 115: 17–32.

Tables (Logarithmic).

GAUSS (F. G.): Fünfstellige vollständige logarithmische und trigonometrische Tafeln. 25. ed. 162+34 p. 8vo. Halle, 1886 .... (M. 2)

GRAVELIUS (G.): Logarithmisch-trigonometrische Tafel für die Hunderttheilung der Quadranten . . . [etc.]. 8vo. Berlin, 1886 .... (M. 6)

HOÜEL (J.): Tables de logarithmes à 5 décimales . . . [etc.]. New ed. enl. 48+119 p. 8vo. Paris, 1886 .... (M. 2)

PRYTZ (H.): Tables d'antilogarithmes. 27 p. 8vo. Copenhague, 1886 .. (M. 2)

SCHRÖN (L.): Siebenstellige gemeine Logarithmen der Zahlen von 1 bis 108000. 20. ed. 8vo. Braunschweig, 1886 .... (M. 2.40)

VEGA: Logarithmisch-trigonometriches Handbuch. 69. ed. F. Tietjen. 28+575 p. 8vo. Berlin, 1886 .... (M. 4. 20)

Tacubaya Observatory.

ANGUIANO (A.): Longitud del Observatorio astronómico nacional mexicano por señales telegráficas . . . entre St. Louis, Missouri, y Tacubaya . . . 88 p. 8vo. México, 1886.

Taschkent Observatory.

[Memoirs . . .] 97 p., 14 pl. 4to. Moscow, 1885.
Printed in Russian. *Rev.* by LINDEMANN (E.) Vrtljschr. d. astron. Gesellsch.: 21: 260–266.

Telescopes. *See, also,* EQUATORIALS; OBJECTIVES; REFLECTORS.

DENNING (W. F.): Large *vs.* small telescopes. Obsry., 9: 274–277.

GRUBB (H.): Telescopic objectives and mirrors: their preparation and testing Nature, 34: 85–92.

Telescopes—Continued.

HALL (A.): The images of the stars. Sid. Mess., 5: 97-100.

RANYARD (A. C.): Note with respect to the invention of the achromatic telescope. Month. Not., 46: 460.

SERVUS (H.): Die Geschichte des Fernrohrs bis auf die neueste Zeit. 135 p. 8vo. Berlin, 1886 .... (M. 2.60)

STRUVE (H.): Allgemeine Beugungs-figur in Fernrohren. 15 p. 4to. St. Petersburg, 1886 .... (M. 0.70)

Mém. Acad. imp. d. sc. de St. Pétersb. 7s. v. 34, No. 5.

YOUNG (C. A.): Large telescopes *vs.* small. Obsry., 9: 328.

——: Small telescopes *vs.* large. Sid. Mess., 5: 1-5.

Temple Observatory.

REPORT . . . 1886. 2 p. 8vo. [n. p., n. d.]

Three bodies (Problem of). *See, also,* MECHANICS (Celestial); ORBITS.

BACKLUND (O.): Dr. Harzer's Untersuchungen über einen speciellen Fall des Problems der drei Körper. 20 p. 8vo. St. Petersburg, 1886 .... (M. 0.80)

Repr. from: Bull. Acad. imp. d. sc. de St. Pétersb. 31: 125-138.

HARZER (P.): Untersuchungen über einen speciellen Fall des Problems der drei Körper. 156 p., 1 pl. 4to. St. Petersburg, 1886.

Mém. Acad. imp. d. sc. de St.-Pétersb., 7. s., vol. 34, No. 12.

LINDSTEDT (A.): Sur les séries trigonométriques dans le problème des trois corps. Bull. astron., 3: 217-221.

RADAU (R.): Quelques remarques sur l'élimination des nœuds dans le problème des trois corps. Bull. astron., 3: 113-125.

SEYDLER (A.): Ausdehnung der Lagrangeschen Behandlung des Dreikörper-Problems auf das Vierkörper-Problem. 20 p. 4to. Prag, 1886 ...... (M. 0.60)

Tides.

DARWIN (G. H.): Dynamical theory of the tides of long period. Proc. Roy. Soc., 41: 337-342.

Time.

BILFINGER (G.): Die Zeitmesser der antiken Völker. 78 p. 4to. Stuttgart, 1886.

Time (Determination of).

DÖLLEN (W.): Ephemeriden auf das Jahr 1887 zur Bestimmung von Zeit und Azimut mittelst des tragbaren Durchgangsinstruments im Verticale des Polarsterns. 24 + 27 p. 4to. St. Petersburg, 1886.

Time (Universal). *See, also,* DAY (Astronomical).

CHRISTIE (W. H. M.): Universal, or world, time. Nature, 33: 521-523. *Also:* Pop. Sc. Month., 29: 795-802.

Lecture at the Royal Institution, March 19, 1886.

[FLEMING (S.)]? Prime meridian time. Nature, 33: 259-262.

Toulouse Observatory.

ANNALES de l'Observatoire de Toulouse. Tome II, renfermant une partie des travaux exécutés de 1879 à 1884, sous la direction de B. Baillaud. 45 + 120 + 7 + 214 p. 4to. Paris, 1886.

Turin Observatory.

DORNA (A.): Nozioni intorno all' equatoriale. Nota terza. 23 p. 8vo. Torino, 1886.

——: The same. Nota quarta. 21 p. 8vo. Torino, 1886.

——: Ricerche per riconoscere se la deviazione della mira meridiana dell' Osservatorio di Torino a cavoretto dal piano del meridiano è sensibilmente nulla come nel 1828. Nota seconda. 12 p. 8vo. Torino, 1886.

Tycho Brahe. *See, also,* ASTRONOMY (History of).

TRIANGULORUM planorum et sphæricorum praxis arithmetica, qua maximus eorum, præsertim in astronomico usus compendiose explicatur. Nunc primum edidit F. J. Studnicka. 40 p. 4to. Pragæ (1591), 1886.................(M. 21)

United States Naval Observatory.

ASTRONOMICAL observations . . . 1883. App. I. The six inner satellites of Saturn, by A. Hall. 74 p. 4to. Washington, 1886.

——: The same. App. II. Observations for stellar parallax, by A. Hall. 67 p. 4to. Washington, 1886.

——: The same. App. III. The observatory temperature room and competitive trials of chronometers in 1884 and 1886. 35 p., 9 pl. 4to. Washington, 1886.

REPORT of the superintendent . . . [October 20, 1886]. 20 p. 8vo. Washington, 1886.

Uranus. p* 139.

WILSON (H. C.): [Observations June 18 to July 5, 1883.] Astron., Nachr., 114: 313.

Uranus (Satellites of).

MARTH (A.): Ephemeris of the satellites of Uranus. Month. Not., 47: 75–78.

Variable Stars, p* 109.

HALL (M.): Density of the sun compared with that of Algol. Obsry., 9: 224.

PICKERING (E. C.): Observations of variable stars in 1885. Proc. Am. Acad. Arts and Sc., 21 (n. s., 13): 319–335, 1886. *Also*, Reprint.

Venus. p* 133.

THACKERAY (W. G.): Semidiameter of Venus. Month. Not., 46: 335–336.

Warner Observatory.

HISTORY and work of the Warner Observatory, 1883–1886. Vol. 1. 70 p. il. 8vo. Rochester, 1887.

Washburn Observatory.

PUBLICATIONS of the Washburn Observatory of the University of Wisconsin. Vol. 4. 4 + 221 + 25 p. 8vo. Madison, 1886 ....(M. 7.50)

Washington University Observatory.

PRITCHETT (H. S.): The Washington University equatorial after the "Lick pattern." Sid. Mess., 5: 65–67.

Yale College Observatory.

REPORT for the year [ending June 1, 1886]. 15 p. 8vo. [New Haven, 1886.]

Zodiacal light. p* 126.

NECROLOGY OF ASTRONOMERS: 1886.

AUERBACH (CARL HEINRICH, AUGUST); b. February 24, 1813, at Berlin; d. at Gohlis, October 22, 1886, æt 73.

BASSNETT (THOMAS); d. February 26, 1887, æt. 79.

BOILEAU (Gen. J. T.); b. May 26, 1805, at Calcutta; d. November 9, 1886, æt. 81.

DORNA (ALESSANDRO), director of the Turin Observatory; b. February 13, 1825, at Asti; d. at Borgo San Pietro, near Turin, August 19, 1886, æt. 61.

FELDKIRCHNER (CHRISTOPH), first assistant at the Munich Observatory; b. February 26, 1823; d. March 1, 1886, æt. 63.

HOÜEL (JULES), professor of mathematics at Bordeaux; b. ——, 1823, at Thaon; d. June 14, 1886, at Périers, æt. 63.

KRAPOTKIN (ALEXANDER); b. ——; d. at Tomsk, August 6, 1886, æt. 45.

MAYWALD (GUSTAV ADOLPH RICHARD), computer on the Berliner Jahrbuch; b. February 13, 1817, at Leuthen; d. July 19, 1886, æt. 69.

VON OPPOLZER (THEODOR); b. October 26, 1841, at Prague; d. December 26, 1886, at Vienna, æt. 45.

PEARSON (*Rev.* JAMES); b. 1826, at Preston, England; d. April 8, 1886, at Fleetwood, æt. 60.

SAXBY (*Rev.* STEPHEN HENRY); b. ——, 1831; d. August 5, 1886, æt. 55.

TALMAGE (CHARLES GEORGE), director Leyton Observatory, b. November 12, 1840, at Greenwich; d. March 20, 1886, at Knots Green, Leyton, æt. 45.

WAGNER (AUGUST), vice-director Pulkowa Observatory, b. September 10, 1828, at Nurft; d. at Pulkowa, November 14, 1886, æt. 58.

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no. 4

L.O. from ESH.

REPORT ON ASTRONOMICAL OBSERVATORIES.

(1886)

By George H. Boehmer.

from Sm. Report for 1886.

INTRODUCTORY NOTE.

In the Annual Report of the Smithsonian Institution for 1879 Prof. E. S. Holden, then connected with the U. S. Naval Observatory at Washington, published a preliminary account of astronomical observatories, principally American, although reports of a few foreign observatories, translated from the "Vierteljahrsschrift der Astronomischen Gesellschaft," were incorporated.

In the beginning of 1880 a circular* was sent to the directors of observatories, requesting their co-operation in the continuation of the work. Professor Holden, however, having accepted a call to Madison, Wis., as director of the Washburn Observatory, the editing of the notes received was entrusted to the writer, and the result was published in the Smithsonian Annual Report for 1880 (pp. 623–739).

Since then, by correspondence, a large amount of material has been collected, and this is now presented, classified under the two heads: I. American observatories, and II. Foreign observatories. Notwithstanding, however, the care given by comparison with other works on the subject, such as "A. Lancaster, Liste Générale des Observatoires et des Astronomes," "U. S. Nautical Almanac," "Connaissance des Temps," "Astronomische Nachrichten," etc., the report is not regarded as complete; and the directors of the observatories and astronomers generally into whose hands the paper may come are earnestly requested to freely criticise it and to furnish the corrections and additions necessary to secure, for another year, a more correct and complete account of their respective observatories.

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*Smithsonian Annual Report, 1880, p. 623.

I. AMERICAN OBSERVATORIES

AKRON, OHIO.

Buchtel College Observatory.

Longitude from Washington, ——.
Latitude, ——.
Director, ——.

ALBANY, NEW YORK.

Dudley Observatory.

Longitude from Washington, 13^m 12.87^s E.
Latitude, 42° 39′ 49.5″ N.
Directors: B. A. GOULD, 1854.
O. M. MITCHEL, 1859.
G. H. HOUGH, 1862.
L. BOSS, 1875.

Founded in 1851, by subscription, the principal subscriber being Mrs. BLANDINA DUDLEY. Built in the form of a cross, with wings east and west for the meridian instruments. Finished in 1854, and inaugurated in 1856.

ALFRED CENTER, NEW YORK.

Observatory of Alfred University.

Longitude from Washington, 2^m 55^s W.
Latitude, 42° 15′ 19.8″ N.
Instructors: Prof. A. B. KENYON,
Prof. H. C. COON.

The observatory has not been used for original research, but only for class instruction.

ALLEGHENY CITY, PENNSYLVANIA.

Allegheny Observatory.

Longitude from Washington, 11^m 50.84^s W.
Latitude, 40° 27′ 41.6″ N.
Director: S. P. LANGLEY.

Founded in 1860, enlarged in 1873, and further enlarged in 1881. Equipped in 1867, principally through the liberality of W. THAW, of Pittsburgh, to whom its subsequent accessions are also largely due. The dome, 22 feet in diameter, contains the equatorial.

The observatory in 1870, under its present director, inaugurated and carried into active operation the system of time service on a scale then, and probably still, as regards the systematic distribution of time to railroads, the most extensive in the country. The observatory is the standard of time for a large portion of the railroads connecting the Atlantic and the Mississippi. It is better known by its investigations in solar physics, to which the director has given his principal attention for the last ten years.

INSTRUMENTS:

(b) *Meridian transit instruments:* Makers, TROUGHTON & SIMMS; aperture, 4 inches; magnifying power, 150 diameters.

(c) *Equatorial instruments:* Makers, FITZ, reworked by CLARK; aperture of objective, 13 inches; magnifying powers of eye-pieces, 50 to 1,200; equatorial carries a 12-inch flat mirror by CLARK at south end of its polar axis; also, position filar micrometer, polarizing solar eye-piece; apparatus for projecting solar image; eight other subsidiary pieces.

(d) *Spectroscopes:* One employing large RUTHERFURD grating; one with small grating; one 2-prism spectroscope; apparatus for using large equatorial as collimator, etc.

(e) *Photometers and other subsidiary apparatus:* A variety of thermopiles, used in connection with a THOMPSON reflecting galvanometer; large BUNSEN photometer; small portable heliostat, etc.

(f) *Chronographs:* One of BOND'S pattern, built by HAMBLET.

(g) *Clocks:* Mean time; two by HOWARD, both break-circuit: sidereal; one by FRODSHAM, break-circuit.

(h) *Chronometers:* Mean time; one by FRODSHAM: sidereal; one FRODSHAM, break-circuit.

(i) *Miscellaneous:* One reflecting telescope of 6½-inch aperture, specially used for obtaining an image projected any size without the employment of any enlarging lenses; one Foucault siderostat and a large number of special pieces of apparatus for the study of radiant heat.

The observatory has never issued any regular series of annals; for abstracts of the results of its work reference must be made to the Comptes Rendus de l'Institut de France, to the Memoirs of the U. S. National Academy, to the pages of the American Journal of Science, of the Annales de Chimie et Physique, Wiedemann's Annalen, and to various foreign and domestic scientific journals.

Electric appliances for the distribution of exact time, automatically and continuously to points outside the observatory.

AMHERST, MASSACHUSETTS.

The Lawrence Observatory of Amherst College.

Longitude from Washington, $18^m\ 4.8^s$ E.
Latitude, 42° 22′ 15.6″ N.
Director: DAVID P. TODD.

Ann Arbor, Michigan.

Detroit Observatory.

Longitude from Washington, 26^{m} 43.1^{s} W.
Latitude, 42° 16′ 48″ N.
Directors: F. Brünnow, 1854.
J. C. Watson, 1858.
M. W. Harrington, 1879.

Annex of the University of Michigan. Projected in 1852, commenced in 1853, completed in 1854. The principal structure is surmounted by a dome and has two wings. About thirty planetoids have been discovered here.

Annapolis, Maryland.

U. S. Naval Academy Observatory.

Longitude from Washington, 2^{m} 15.61^{s} E.
Latitude, 38° 58′ 53.48″ N.

Authority for longitude, U. S. Coast Survey; for latitude, Professor Chauvenet.

Director: Lieut. Commander P. F. Harrington, head of department of astronomy, navigation, and surveying.

The officers attached to the observatory are occupied in duties of instruction in the department of astronomy, navigation, and surveying. The instruments are used in the course of instruction, but regular observations are not made for purposes of astronomical investigation.

Instruments:

(*a*) *Meridian circle:* One; maker, Repsold, Germany; diameter of circles, 30 inches; divided to 2′; read by 4 microscopes to 2″. Aperture of objective, 4 inches; for observations of the sun, aperture employed, — inches; magnifying power ordinarily employed, 80 diameters.

(*b*) *Meridian transit instrument:* Maker, Würdemann; aperture, 2 inches; magnifying power, 40 diameters.

(*c*) *Equatorial instrument:* Makers, Alvan Clark & Sons; aperture of objective, 7¾ inches; magnifying power of eye-pieces, 40, 106, 553, and 966; micrometer eye-pieces, 89, 226, 673.

(*f*) *Chronographs:* One Morse fillet; one Transit of Venus Commission.

(*g*) *Clock:* One sidereal; makers, Arnold, Chas. Frodsham, London.

(*h*) *Chronometers:* Five mean time; makers, Negus, Nos. 1030, 1088, 1260; Dent, 2,099; Hatton, 262: two sidereal; maker, Negus, Nos. 1520, 1527.

(*i*) *Miscellaneous:* One Talcott's zenith telescope (Würdemann); one Transit of Venus telescope (Stackpole); portable transit (Würdemann).

BALTIMORE, MARYLAND.

Denmore Observatory.

Longitude from Washington, ———.
Latitude, ———.
Director: ———.

BARNESVILLE, OHIO.

Olney Observatory.

Longitude from Washington (about), 16^m W.
Latitude (about), 40° N.

Authority for longitude and latitude, A. von Steinwehr's map of Ohio.

Director: CHARLES E. GAUSE, Jr.

No systematic observations. Instruments used only for purpose of class instruction.

BATTLE CREEK, MICHIGAN.

High School Observatory.

Longitude from Washington, ———.
Latitude, ———.
Director: ARTHUR K. BARTLETT.

INSTRUMENTS:

(*a*) *Meridian circle:* One; aperture of objective, 4 inches; for observations of the sun, aperture employed, 2 to 4 inches; magnifying power ordinarily employed, 75 diameters.

(*i*) *Miscellaneous:* The only instrument at present used in the observatory is a 4-inch achromatic telescope, which was purchased by the board of education about nine years ago, for the use of students and teachers in the high school. It was manufactured by PIKE, the New York optician, and is mounted upon a portable tripod stand, provided with all the necessary adjustments. For the general observations of astronomy it is regarded as one of the best telescopes in this State.

BELOIT, WISCONSIN.

Smith Observatory of Beloit College.

Longitude from Washington, ———.
Latitude, ———.
Director: ———.

BROOKLYN, NEW YORK.

I. *Private Observatory of Mr. W. T. Gregg.*

Longitude from Washington, ———.
Latitude, ———.
Director: W. T. GREGG.

(*c*) *Equatorial instrument:* Maker, WILLIAM T. GREGG; aperture of objective, 6¼ inches; magnifying powers of eye-pieces, 50 to 600.

II. *Private Observatory.*

Longitude from Washington, ——
Latitude, ——
Director: G. P. SERVISS.

INSTRUMENTS:

(*c*) *Equatorial instruments:* One telescope; maker, JOHN BYRNE, of New York; aperture of objective, 3⅜ inches; magnifying powers of eye-pieces, 50, 106, 160, 250, and 320.

(*i*) *Miscellaneous:* The director remarks: "My telescope is mounted equatorially on a tripod stand. The objective is of excellent quality. I can see the companion of α Lyræ and both the debilissima in *epsilon* Lyræ with ease. It also easily separates double stars only 1.5″ apart. Under favorable circumstances I have seen five of Saturn's moons. I have no observatory, and my observations are made from lofty windows having a southerly and westerly exposure, and occasionally from the roof of my residence on Brooklyn Heights. In observing Jupiter and Saturn I ordinarily employ powers of 160 and 250, and occasionally 320. For special purposes I have used a power of 480 with good effect."

BUFFALO, NEW YORK.

I. *Private Observatory.*

Longitude from Washington, ——.
Latitude, ——.
Director: JAMES W. WARD.

INSTRUMENTS:

(*b*) *Meridian transit instrument.*

(*c*) *Equatorial instrument:* Maker, JOHN BYRNE, New York City; aperture of objective, 4 inches; magnifying powers of eye-pieces, 60, 80, 130, 200, 330, 400; useful with Barlow lens to 550.

(*h*) *Chronometer:* One mean time; maker, SAMUELS, Liverpool.

(*i*) *Miscellaneous:* DOLLOND, 1¾ inches, used roughly on alt azimuth swivel for southern transits, etc.

II. *Private Observatory.*

Longitude from Washington, $7^{m}\ 21.65^{s}$ W.
Latitude, 42° 54′ 9.5″ N.
Authority for longitude and latitude: Report for 1862 of the regents of University of State of New York.
Director: HENRY MILLS.

INSTRUMENTS:

(*c*) Telescope not equatorial; maker, BARDON; aperture of objective, 3 inches; magnifying powers of eye-pieces, 50 to 250.

CAMBRIDGE, MASSACHUSETTS.

I. *Private Observatory.*

Longitude from Washington, $23^m\ 41.26^s$ E.
Latitude, 42° 22′ 58.8″ N.
Director: E. L. TROUVELOT.

II. *The Astronomical Observatory of Harvard College.*

Longitude from Washington, $23^m\ 41.11^s$ E.
Latitude, 42° 22′ 48.3″ N.
Directors: W. C. BOND, 1839.
G. P. BOND, 1859.
J. WINLOCK, 1866.
EDWARD C. PICKERING, 1876.

Annexed to Harvard College; projected in 1815; ground acquired in 1842; instruments set up in 1844–'48; a central tower and dome, two wings, with a small dome on the western wing. Here it was that G. P. BOND discovered in 1848 the seventh satellite of Saturn (Hyperion), and in 1850 the dusky interior ring inside the bright rings of that planet. Among the chronographs, this observatory possesses the original instrument of W. C. BOND, mounted in 1850.

INSTRUMENTS:

(*a*) *Meridian circle:* Makers, TROUGHTON & SIMMS (glasses by ALVAN CLARK & SONS); diameter of circles, 36 inches; divided to 5′; each circle read by 4 microscopes to 0.1″; aperture of objective, 8¼ inches; for observations of the sun, aperture employed, 8¼ inches; magnifying power ordinarily employed, 300 to 350 diameters. (*a′*) East transit circle, by TROUGHTON & SIMMS; diameter of circles, 48 inches; divided to 5′; each circle read by 4 microscopes to 0.2″; aperture of objective, 4¼ inches.

(*b*) *Meridian transit instruments:* One made by HERBST, of Pulkowa; aperture, 2¾ inches; magnifying power, up to 200 diameters. (*b′*) Large photometer, mounted in the meridian, for comparing images of stars during transit.

(*c*) *Equatorial instruments:* One made by MERZ; aperture of objective, 15 inches; magnifying powers of eye-pieces, 100 to 2,000. (*c′*) West equatorial, by ALVAN CLARK & SONS; aperture, 5¼ inches.

(*d*) *Spectroscopes:* Three, described in vol. viii of the Annals of the Observatory.

(*e*) *Photometers and other subsidiary apparatus:* One ZÖLLNER photometer, and several photometers of other kinds.

(*f*) *Chronographs:* Two spring governors, by W. BOND & SON; one small barrel chronograph.

(*g*) *Clocks:* One mean time; maker, BOND, 394; one sidereal; makers, FRODSHAM, 1327; BOND, 312.

(*h*) *Chronometers:* Two sidereal; makers, FRODSHAM, 3451; BOND, 236; one thermometric chronometer, FRODSHAM, 3424.

(*i*) *Miscellaneous:* Comet-seeker and other small telescopes and apparatus.

CAMBRIDGEPORT, MASSACHUSETTS.

Private Observatory.

Longitude from Washington, 23^m 49^s E. (approximately).
Latitude, 42° 21′ 56″ N. (approximately).
Director: E. F. SAWYER.

CHICAGO, ILLINOIS.

Dearborn Observatory.

Longitude from Washington, $42^m\ 14.69^s$ W.
Latitude, 41° 50′ 1″ N.
Directors: T. H. SAFFORD, 1865.
ELIAS COLBERT, 1874.
G. W. HOUGH, 1879.

Annexed to the university. Founded by subscription in 1822.

INSTRUMENTS:

(*a*) *Meridian circle:* Makers, REPSOLD & SON; diameter of circle, 40 inches; divided to 2′; read by 4 microscopes to 0.1″; aperture of objective, 6 inches; for observations of the sun, aperture employed, 3 inches.

(*c*) *Equatorial instrument:* Makers, ALVAN CLARK & SONS; aperture of objective, 18½ inches; magnifying powers of eye-pieces, positive, 120, 190, 287, 385, 900; negative, 135, 225, 450, 900.

(*f*) *Chronograph:* G. W. HOUGH; cylinder recording.

(*g*) *Clocks:* One mean time; makers, HOWARD & CO.; GRAHAM escapement, mercury pendulum; one sidereal; makers, CHARLES GORTNER & CO., London; GRAHAM escapement, mercury pendulum.

(*h*) *Chronometer:* Sidereal; makers, BOND & SON.

(*i*) *Miscellaneous:* Signal mean time clock for transmitting time signals.

CINCINNATI, OHIO.

Cincinnati Observatory. (See *Mount Lookout.*)

CLINTON, NEW YORK.

Litchfield Observatory of Hamilton College.

Longitude from Washington, $6^m\ 34.65^s$ E.
Latitude, 43° 3′ 17″ N.

Authority for longitude and latitude: Longitude telegraphically determined from Cambridge, Mass. Latitude by stars in prime vertical.

Director: C. W. F. PETERS.

Founded in 1852 by subscription; completed in 1855; central edifice with wings east and west. Forty-two planetoids have been discovered here.

INSTRUMENTS:

(*b*) *Meridian transit instrument:* Maker, W. WÜRDEMANN, Washington, D. C.; aperture 2½ inches; magnifying power, — diameters.

(*c*) *Equatorial instrument:* One made by SPENCER & EATON; aperture of objective, 13½ inches; magnifying powers of eye-pieces, 80 to 1600. (*c*′) One by STEINHEIL SONS; aperture, 4 inches. (*c*″) One by HUGO SCHRÖDER; aperture, 5 inches.

(*d*) *Spectroscope:* One direct vision 5 prisms; attached to the 4-inch STEINHEIL refractor.

(*f*) *Chronograph:* By WM. BOND & SON, Boston, Mass.

(*g*) *Clocks:* Mean time; makers, WM. BOND & SON.

(*h*) *Chronometer:* Sidereal; makers, WM. BOND & SON.

COLUMBIA, MISSOURI.

The Laws Observatory, University of the State of Missouri.

Longitude from Washington, $1^h\ 1^m\ 6^s$ W.
Latitude, 38° 56′ 51.5″ N.
Authority for longitude and latitude: JOSEPH FICKLIN and THOMAS J. LOWRY.
Director: JOSEPH FICKLIN.

During February and March, 1880, the old observatory building, which stood a few feet west of the main university edifice, was moved and enlarged. It now stands on the beautiful eminence in the campus near the chalybeate spring. The meridian line of each pier now passes between the university building and the president's mansion. In this position a good horizon is secured. In the old position the horizon was obstructed on the north by the scientific building, and on the east by the university building.

The old dome was found to be too small for the equatorial recently purchased, and a brick addition was made at the east end for the accommodation of this instrument. The whole building is 63 feet long from east to west, and fronts east.

The present greatly improved condition of the observatory is due to the liberality of the president, Dr. S. S. LAWS, who, for the advancement of astronomical science, has given to the university more than $2,000, in order to procure the telescope and put it in complete working order, and to move and enlarge the observatory building.

INSTRUMENTS:

(*a*) *Meridian circle*: One; maker, BRUNNER, of Paris; diameter of circle, 10½ inches; divided to 5′; read by two microscopes to 3″; aperture of objective, $2\frac{1}{16}$ inches; for observations of the sun, aperture employed, $2\frac{1}{16}$ inches; magnifying power ordinarily employed, 50 diameters.

(*c*) *Equatorial instruments*: One made by HENRY FITZ, of New York; aperture of objective, $4\frac{1}{16}$ inches; magnifying powers of eye-pieces, 30 to 240; one made by MERZ & SON, of Munich; aperture of objective, $7\frac{1}{2}$ inches; magnifying powers of eye-pieces, 80 to 1018. This instrument is furnished with a micrometer, reflecting prisms and sun-shades. It is driven by clock-work. The hour circle is 10 inches in diameter. It is graduated on silver to single minutes, and read by two verniers to 4 seconds of time. The declination circle is 15 inches in diameter. It is graduated on silver to 10 minutes, and read by two verniers to 10 seconds of arc. The finder was made by ALVAN CLARK & SONS, of Cambridgeport, Mass. It has an aperture of $1\frac{7}{8}$ inches and a focal length of $17\frac{1}{2}$ inches.

(*g*) *Clocks*: One mean time; maker, RIGGS, of Philadelphia: one sidereal; makers, GREGG & RUPP, of New York.

(*i*) *Miscellaneous:* The instrumental equipment includes also a sextant made by E. & G. W. BLUNT, of New York; the arc is graduated on silver, and reads by a vernier and miscroscope to 10 seconds. An alt-azimuth instrument, made by E. & G. W. BLUNT; it has an aperture of $2\frac{1}{8}$ inches; the circles are 12 inches in diameter and graduated to 10 minutes; the horizontal circle has four verniers with microscopes and the vertical circle two, and each reads to 10 seconds. A Transit theodolite, made by GREGG & RUPP, of New York.

COLUMBUS, OHIO.

Private Observatory.

Longitude from Washington, $23^{m}\ 54^{s}$ W.
Latitude, 40° 0′ 1.5″ N.
Authority for longitude and latitude: U. S. Coast Survey for State-House dome, 2 miles distant.
Director: R. W. MCFARLAND.

INSTRUMENTS:

(*c*) *Equatorial instrument:* Makers, ALVAN CLARK & SONS; aperture of objective, 5 inches.

(*g*) *Clock:* Mean time; makers, PARKINSON & FRODSHAM.

CRETE, NEBRASKA.

Boswell Observatory of Doane College.

Longitude from Washington, ———.
Latitude, ———.
Director: ———.

DUBUQUE, IOWA.

Dubuque Observatory.

Longitude from Washington, $54^{m}\ 27.61^{s}$ W.
Latitude, 42° 29′ 38″ N.
Authority for longitude and latitude: Boundary line between the States of Illinois and Wisconsin, projected through the city of Dubuque; and telegraphic record of star transits at Ann Arbor and Dubuque.
Director: ASA HORR, M. D. Under the supervision of Prof. J. C. WATSON, in 1865.

INSTRUMENTS:

(*b*) *Meridian transit instrument:* Maker, WM. WÜRDEMANN, Washington, D. C. Aperture, 1½ inches; magnifying power sufficient to note time by stars of the 10th magnitude. Finding circle, 4½ inches diamèter, reading by verniers and lenses to half a minute of arc. The pier extends 17 feet into the ground, through clay to gravel; it is 7 feet 6 inches diameter at base, 3 feet at top, which is 4 feet above the surface; is surrounded by a brick wall, 8 inches from the stone shaft, the space between (at the surface of the ground) being stuffed with oakum. The Y's rest on thin brass supports on the top of *stone pillars*, instead of the iron frame which acme with the instrument.

(*g*) *Clock:* Mean time; makers, HOWARD & CO., Boston. Tower clock, reliable to less than a second a day through all extremes of temperature.

(*h*) *Chronometer:* Mean time; maker, K. ZIMMERMAN, Liverpool, England.

DUE WEST, SOUTH CAROLINA.

Astronomical Observatory of Erskine College.

Longitude from Washington, ———.
Latitude, ———.
Director: Rev. W. M. GRIER, D. D.

EASTON, PENNSYLVANIA.

La Fayette College Observatory.

Longitude from Greenwich, ———.
Latitude, ———.
Director: ———.

ELIZABETH, NEW JERSEY.

Observatory.

Longitude from Washington, $11^{m}\ 22.2^{s}$ E.
Latitude, 40° 40′ 19″ N.
Authority for latitude and longitude: United States Coast Survey.
Director: CHARLES W. PLYER.

INSTRUMENTS:

(*b*) *Meridian transit instrument:* Makers, JOHN BLISS & SONS, New York; aperture, 1 inch; magnifying power. 10 diameters.

(*c*) *Equatorial instrument:* Maker, HENRY G. FITZ; aperture of objective, 6¼ inches. Nine eye-pieces, from 50 to 630.

FORDHAM, NEW YORK.

Private Observatory.

Longitude from Washington, 12^{m} 40.47^{s} E.
Latitude, 40° 52′ 31.3″ N.
Authority for longitude and latitude: Coast Survey map of 1863 and American Ephemeris, 1879, assuming the longitude and latitude of New York, given in the Ephemeris, to be that of the city hall.
Director: WILLIAM MEIKLEHAM.

Observatory removed to *Riverdale, New York.*

FORT DODGE, IOWA.

Private Observatory.

Longitude from Washington, 1^{h} 8^{m} 5^{s} W.
Latitude, 42° 30′ N.
Authority for longitude and latitude: F. HESS.
Director: F. HESS.

INSTRUMENTS:

(*b*) *Meridian transit instrument:* Makers, J. BROWN & SON, New York; aperture, 1 inch; magnifying power, 10½ diameters, with horizontal and vertical circle, each reading to 1.

(*c*) *Equatorial instrument:* Aperture of objective, 2⅝ inches; for observations of the sun, aperture employed, 2⅝ inches; magnifying power ordinarily employed, 50 diameters.

(*g*) *Clock:* Mean time; maker, G. M. WHEELER, Elgin, Ill.

(*i*) *Miscellaneous:* One TROUGHTON sextant and artificial horizon.

GEORGETOWN, DISTRICT OF COLUMBIA.

Observatory of Georgetown College.

Longitude from Washington, 6.2^{s} W.
Latitude, 38° 54′ 26.07″ N.
Directors: JAMES CURLEY, S. J.
JOHN G. HAGEN, S. J.

The observatory was ready for use on January 1, 1846, and was built by means of a donation of the Rev. MEREDITH JENKINS, of Baltimore.

Miscellaneous observations were made first to determine the latitude and longitude with great accuracy. It is now used principally for instruction.

The plan of this observatory was made and the first instrument ordered in the year 1841. The excavations for the building were commenced in 1843, and three years later observations began. The building is situated on a hill, northwest of the college, commanding a free horizon. It is 60 feet long by 30 feet wide, comprising two wings on the east and west sides, and two rooms in the middle, viz: The clock-room and library, besides cellar and dome.

The west wing has a transit instrument by ERTEL & SON, 7 feet long and 4½ inches aperture; the east wing a meridian circle by TROUGHTON & SIMMS, reading to fractions of a second by four microscopes, with an object-glass of 4 inches clear aperture. The equatorial was also made by TROUGHTON & SIMMS, has 4.8 inches aperture with powers from 25 to 400, clockwork and micrometer, strong mounting and large circles. The dome measures 20 feet in diameter, and was intended for an 8-inch equatorial, which had been ordered in Paris, but had to be replaced by the present one. Two sidereal clocks, originally mounted in the east and west wings, and a meantime chronometer by MOLYNEAUX, of London, a universal instrument by ERTEL & SON, a reflecting circle by TROUGHTON & SIMMS, and two 3-inch telescopes completed the original outfit of the observatory, which, together with the building, cost about $13,000, a small sum compared to the prices of the present day. The expenses were defrayed for the most part by a donation of the Rev. THOMAS MEREDITH JENKINS, S. J., of Baltimore.

The building of the observatory and the mounting of the instruments was superintended by the first director, JAMES CURLEY, S. J. The geographical position was determined by him in 1846, the longitude by corresponding observations of moon-culminations at Georgetown and Greenwich, the latitude by upper and lower culminations of circumpolar stars.

The revolution of 1847 brought several Italian professors to Georgetown, among whom were DE VICO, SECCHI, and SESTINI. The former had to leave a few weeks later for London on some important business, where he died of typhoid-fever on November 15, 1848, only forty-three years of age; but the gold medal is still preserved here, which he received from the King of Denmark for his discovery of six comets (I, 1844; II, 1847; I, V, VI, IX, 1846) while director of the observatory at the Roman College. He was a member of the Royal Astronomical Society of London.

F. SECCHI, then thirty years of age, taught physics for one year and then returned to Rome to enter upon his career in physical astronomy, but his first interest in this study dates from the observations he made with F. CURLEY at Georgetown.

F. SESTINI began observations of star-colors in 1849, the manuscript of which is preserved in the library of the observatory. The list of his stars was taken from Baily's Catalogue, and is the same which he had observed at Rome. The result was that in general there is no difference in color observed in Italy and in our sky. In 1850 he made drawings of sun-spots from September 20 till November 6, missing only six days out of forty-eight. The drawings were lithographed and, together with a journal and preface, published in the appendix of the Washington Astronomical Observations for 1847. A duplicate set of copies is still in the library of the observatory.

In 1852 a quarto volume of 215 pages, containing a description of the observatory, with eight plates and reduction tables for time observations, was published and distributed by the director. That nothing more has appeared from his pen finds sufficient explanation in the facts that he considered the observatory mainly as a means of education, and that he is now in the venerable age of ninety-three years.

As the centennial celebration of the foundation of the college drew near, the regents of the university placed the observatory in charge of a younger director and put a liberal allowance at his disposal. Almost a thousand dollars were expended for repairs of the building, drying and warming the cellar, roofing, painting, and so on. The problem of revolving the heavy dome was successfully solved by Mr. GARDNER, of the Naval Observatory. A spring which allows the vertical shaft of the gearing a horizontal play of 1 inch, so as to keep the pinion always in contact with the rack, and a large (vertical) steering wheel, with handles, enable a strong man to turn the dome half round in two minutes.

Nearly another thousand dollars were spent on old and new instruments. The equatorial received a helioscope, one of the 3-inch glasses was changed into a portable equatorial, with circles, the other into a comet-seeker; the clocks were cleaned and mounted in double glass cases on the large equatorial pier, one running on sidereal the other on mean time, both provided with the Gardner spring contact, and a new chronograph by FAUTH & CO., of Washington, placed between them. A triple electric-wire system is now being run to the switch-board in the clock-room, one making connection with the U. S. Naval Observatory, another connecting clocks and observing keys with the chronograph, and a third giving incandescent illumination to the field and reading microscopes of the equatorial and transit instruments. The arrangement of the switch-board has been made by Mr. WILLIAM C. WINLOCK, assistant observer at the U. S. Naval Observatory, and is the same as in the observatories of Harvard College and Mount Hamilton, Cal.

The transit instrument and meridian circle are still awaiting a thorough examination, and piers will have to be built for the smaller instruments and for collimators.

The equatorial is the only instrument now ready for use, and will be mainly employed for variable star work. All the known variables, from the equator down to the horizon, have been put on the observing list, while the northern sky is left to the care of more northern observatories. Star occultations and comets will be taken in occasionally. If the staff of the observatory be raised, as is hoped, to three regular observers and one servant, the establishment will be able to produce useful results.

GLASGOW, MISSOURI.

Morrison Observatory.

Longitude from Washington, $1^h\ 3^m\ 5.93^s$ W.
Latitude, 39° 16′ 16.75″ N.
Authority for longitude: Exchange of clock-signals with the Naval Observatory in June and July, 1879, five nights; latitude, from circumpolar stars observed on meridian circle.
Director: C. W. PRITCHETT.

The observatory was founded, 1875–'76, by the liberality of Miss BERENICE MORRISON, of Saint Louis.

INSTRUMENTS:

(*a*) *Meridian circle:* One; makers, TROUGHTON & SIMMS; diameter of circles, 24 inches; divided to 5′; read by 4 microscopes to 1″; aperture of objective, 6 inches; for observations of the sun, aperture employed, 4 inches; magnifying power ordinarily employed, 200 diameters.

(*c*) *Equatorial instrument:* Makers, ALVAN CLARK & SONS; aperture of objective, 12¼ inches; magnifying powers of eye-pieces, 50 to 1,200.

(*f*) *Chronograph:* One.

(*g*) *Clock:* Sidereal; maker, CHARLES FRODSHAM, London.

(*h*) *Chronometer:* Sidereal; maker, T. S. & J. D. NEGUS, New York.

(*i*) *Miscellaneous:* Alt-azimuth, by L. P. CASELLA, London; comet-seeker, by ALVAN CLARK & SONS.

GREENCASTLE, INDIANA.

McKim Observatory of De Pauw University.

Longitude from Washington, $14^m\ 17.91^s$ W.
Latitude. 39° 37′ N.
Director: J. P. D. JOHN.

HANOVER, NEW HAMPSHIRE.

Shattuck Observatory of Dartmouth College.

Longitude from Washington, $19^m\ 3.56^s$ E.
Latitude, 43° 42′ 15.2″ N.
Authority for longitude and latitude, Prof. C. A. YOUNG.
Directors: C. A. YOUNG, 1853.
CHARLES F. EMERSON, 1878.

Founded in 1853 through the liberality of Dr. G. S. SHATTUCK. Consists of a west rotunda and three additions. It has double brick walls and an air chamber with a space of 6 inches (0.15^m) between the walls

INSTRUMENTS:

(*a*) *Meridian circle:* Makers, TROUGHTON & SIMMS; diameter of circle, 30 inches; divided to 5′; read by reading microscopes to 1′, and micrometers to single seconds; aperture of objective, 4 inches; magnifying power ordinarily employed, 120 diameters.

(*c*) *Equatorial instrument:* Makers, ALVAN CLARK & SONS; aperture of objective, 9.25 inches; magnifying powers of eye-pieces, 100 to 1,200, 20 in number.

(*d*) *Spectroscopes:* Large 9-prism CLARK spectroscope; seven prism, double acting (equivalent to 13 prisms), fitting equatorial mentioned above.

(*f*) *Chronograph:* BOND's spring governor.

(*g*) *Clocks:* One mean time: makers, UTZSCHNEIDER & FRAUENHOFER; connected with chronograph; one sidereal; makers, UTZSCHNEIDER & MAHLER, of Munich; connected with chronograph.

(*i*) *Miscellaneous:* Comet-seeker, aperture 3.6 inches, mounted on large tripod; small portable telescope, aperture 3 inches; zenith sector, loaned by Coast Survey, aperture 4 inches; full set of common meteorological apparatus, including a recording barometer; sextant by HARDY, of London.

HASTINGS, NEW YORK.

Private Observatory.

Longitude from Washington, 12^m 42.7^s E.
Latitude, 40° 59′ 25″ N.
Authority for longitude and latitude, U. S. Coast Survey.
Director: HENRY DRAPER.

INSTRUMENTS:

(*b*) *Meridian transit instrument:* Makers, STACKPOLE & BROTHER; aperture, 2 inches; magnifying power, 45 diameters.

(*c*) *Equatorial instruments:* One reflector, 28 inches aperture, made by HENRY DRAPER; (*c′*) one refractor, 11 inches aperture, by ALVAN CLARK & SONS, with photographic corrector.

(*d*) *Spectroscopes:* One diffraction, 1 stellar photographic, 1 automatic, etc.

(*f*) *Chronograph:* One made by HENRY DRAPER.

(*g*) *Clock:* One mean time; maker, HOWARD.

(*h*) *Chronometers:* One mean time; maker, NEGUS: one sidereal; maker, NEGUS.

(*i*) *Miscellaneous:* Altitude and azimuth reflector of 15½ inches aperture.

HAVERFORD COLLEGE, PENNSYLVANIA.

Haverford College Observatory.

Longitude from Washington, $6^m\ 59.33^s$ E.
Latitude, 40° 0′ 36.5″ N.
Authority for longitude and latitude: Observations on moon, culminating stars, and with transit in the prime vertical in the years 1854–'55. [The triangulations from U. S. Coast Survey stations give:

Longitude, $7^m\ 0.47^s$ E.
Latitude, 40° 0′ 49.73″ N.

Director: ISAAC SHARPLESS.

INSTRUMENTS:

(*a*) *Meridian circle:* One; diameter of circles, 26 inches; divided to 15′; read by 4 microscopes to 2″; aperture of objective, 4 inches.

(*c*) *Equatorial instrument:* Makers, HENRY FITZ, re-worked by CLARK; aperture of objective, 8¼ inches; magnifying powers of eye-pieces, 60 to 800.

(*f*) *Chronograph:* BOND's magnetic.

(*g*) *Clocks:* One sidereal; maker, LUKENS: one sidereal; maker, HARPER; mercurial compensation.

(*i*) *Zenith instrument:* Aperture, 2¼ inches; rejuvenated by FAUTH & Co., and to be set up as soon as addition is built to observatory, to determine our latitude.

HUDSON, OHIO.

Hudson Observatory.

Longitude from Washington, $17^m\ 32.06^s$ W.
Latitude, 41° 14′ 42.6″ N.
Authority for longitude and latitude: Prof. ELIAS LOOMIS, LL. D.
Director: CHARLES J. SMITH.

INSTRUMENTS:

(*a*) *Meridian circle:* One; maker, SIMMS, of London; diameter of circles, 18 inches; divided to 5′; read by 3 microscopes to 1″; aperture of objective, 3 inches.

Equatorial instrument: One; maker, SIMMS; aperture of objective, 4 inches; magnifying powers of eye-pieces, 50, 100, 150, 250, 350.

Clock: Sidereal; maker, MOLINEUX; mercurial pendulum.

IOWA CITY, IOWA.

Private Observatory.

Longitude from Washington, $57^m\ 52.5^s$ W.
Latitude, 41° 39′ 8″ N.
Director: C. W. IRISH.

INSTRUMENTS:

(*b*) *Meridian transit instrument:* A small one made by the director himself; aperture, one inch; magnifying power, 11 diameters.

(*c*) *Equatorial instrument:* Maker, CHEVALIER, Paris; aperture of objective, 4 inches; magnifying powers of eye-pieces, 25 to 300.

(*f*) *Chronograph:* A Morse register.

(*g*) *Clock:* One mean time; beating three quarter seconds; of German make.

JERSEY CITY, NEW JERSEY.

Private Observatory.

Longitude from Washington, 11^m 48.49^s E.
Latitude, 40° 42′ 50.30″ N.
Director: HENRY HARRISON.

INSTRUMENTS:

Equatorial: Refractor, new, by JOHN BYRNE; aperture, 4¼ inches; focal length, 39 inches; power of eye-pieces (with insertion of BARLOW lens) from 20 to 400; TROUGHTON position filar micrometer; apparatus for projecting solar image.

Spectroscope: With view telescope and collimator cabinet; length, 7 inches; RUTHERFURD diffraction grating ¾ by 1 inch.

Clock: sidereal, THOMAS.

LANSING, MICHIGAN.

State Agricultural College Observatory.

Longitude from Washington, 29^m 44^s W.
Latitude, 42° 43′ 54″ N.
Director: R. C. CARPENTER.

The observatory is rather for instruction than investigation.

LAWRENCE, KANSAS.

Observatory of the Kansas State University.

Longitude from Washington, 1^h 12^m 47.9^s W.
Latitude, 38° 57′ 15″ N.
Authority for longitude and latitude: FRED W. BRADWELL, late professor of astronomy, Kansas State University.
Director: H. J. S. SMITH.

INSTRUMENTS:

(*b*) *Meridian transit instrument:* Makers, STACKPOLE BROS.; aperture, 2¼ inches.

(*g*) *Clocks:* One mean time; makers, E. HOWARD & CO., Boston (medium): one sidereal; maker, BROCKBANKS, London (old).

(*h*) *Chronometer:* Sidereal; makers, T. S. & J. D. NEGUS, New York (good).

(*i*) *Miscellaneous:* Sextant, by GAMBEY; comet-seeker, 6-inch object glass.

LINWOOD, OHIO.

Private Observatory.

Longitude from Washington, ———.
Latitude, ———.
Director: R. H. MCCLURE.

Situated about one mile E. by S. from Cincinnati observatory.

INSTRUMENTS:

(*c*) One equatorial silvered glass Newtonian reflector. Diameter of the concave reflecting objective, 5½ inches; magnifying powers of the eye-pieces, 60, 100, and 200 diameters. The mirror, tube, and mounting all constructed by Mr. MCCLURE himself.

MADISON, WISCONSIN.

The Washburn Observatory.

Longitude from Washington, $49^m\ 25.8^s$ W.
Latitude, 43° 4′ 36.7″ N.
Authority for longitude and latitude: a pier of the United States Coast and Geodetic Survey, about 500 feet from the observatory, has been connected by a triangulation with the transit room, and the position given refers to the center of the transit circle.
Directors: EDWARD S. HOLDEN, 1880.
GEORGE C. COMSTOCK, 1885.

INSTRUMENTS:

(*a*) *A meridian circle:* Maker, REPSOLD & BROTHER, Hamburg; diameter of circles, about 30 inches; divided to 2′; read by 4 microscopes to 1″. Aperture of objective, 4.8 inches; for observations of the sun, aperture employed, —inches; magnifying power ordinarily employed, — diameters.

(*b*) *Meridian transit instrument:* Makers, FAUTH & Co., Washington; aperture, 3 inches; magnifying power, 60 and 120 diameters; two 12-inch circles divided on the edges: one circle to 10″, the other for setting only. The fine circle has a level for latitude.

(*c*) *Equatorial instrument:* Makers, ALVAN CLARK & SONS; aperture of objective, 15.5 inches; magnifying powers of eye-pieces, 145 to 1200.

(*f*) *Chronograph:* A chronograph by FAUTH & Co., with a conical pendulum.

(*g*) *Clocks:* One mean time; makers, SETH THOMAS CLOCK COMPANY: one sidereal; maker, HOHWU, of Amsterdam.

(*h*) *Chronometers:* One sidereal; maker, BLISS, No. 2786; one sidereal break-circuit, BLISS, No. 2791.

MOUNT HAMILTON, CALIFORNIA.

Lick Observatory of the University of California.

Longitude from Washington, $2^h\ 58^m\ 14.6^s$ W.
Latitude, 37° 21′ 3″ N.
Director: EDWARD S. HOLDEN, 1885.

The Lick Observatory of the University of California owes its origin to the bequest of the late JAMES LICK, of California, who bequeathed to the University of California "a telescope of greater power than any yet made." As the site of his observatory he selected Mount Hamilton, in the Santa Clara Valley.

The following description of the establishment of the observatory is taken from the Scientific American (New York), March 17, 1888:

> In administering their trust the custodians met with legal obstacles and suits brought by his relatives. These delayed the carrying out of his plans, but eventually a settlement was reached. On June 30, 1883, the corner-stone of the observatory to which this article is devoted was laid, and to-day the work is practically complete. When Mount Hamilton was selected as the site for the Lick Observatory, in order to test its atmospheric conditions Prof. S. W. BURNHAM, the discoverer of many double stars, was invited to observe there in 1879. Owing to the dryness of the air and its excellent quality for astronomical work, his 6-inch telescope described many stars, catalogued by Prof. OTTO STRUVE as double, into triple stars. Mr. LICK died in 1876, and the original plans for the observatory were determined by Capt. RICHARD S. FLOYD, president of the trustees, and Mr. T. E. FRASER, superintendent of construction, acting under the advice of Prof. EDWARD S. HOLDEN, and Prof. SIMON NEWCOMB, of the Naval Observatory, in Washington. Many noted astronomers have been interested in the work, and this will probably be the most famous observatory in the world. It owns about 1,550 acres of land, a portion of which will eventually be made into a public park, and the graded road of 26 miles leading to the summit of Mount Hamilton from San José may, perhaps, become a direct route to the Yosemite Valley. Since 1880, when the work was first begun, 7,000 tons of rock and earth have been removed to level a plateau upon which the buildings stand. They are constructed of solid masonry, and are of simple but effective architecture, and include the main building, 287 feet long, containing the directors' and secretary's offices, the library, clock-rooms, etc., with the large dome at its southern end for the large telescope, and a smaller dome for the 12-inch equatorial at the northwest corner, the meridian-circle house, the transit house, the photographic laboratory, and several temporary wooden workshops. The dwelling house of the astronomers, 63 by 60 feet, stands below the summit and is connected with the plateau by a bridge. The surrounding peaks have been named from several famous astronomers.

The large dome, built by the Union Iron Works, of San Francisco, is 75 feet in diameter and its moving parts weigh 100 tons. It revolves upon wheels which run on hardened steel balls. A man merely pushing against it can move the entire dome. The usual motive power is obtained from a water engine which can rotate the dome 360 degrees in less than nine minutes. Its diameter changes one-half inch in the extreme change of temperature, and its track is given a smooth and oiled surface to slide upon. The observing slit is 9½ feet wide, and the pintle of the shutter is placed eccentrically. A practical device for carrying the observer to the eye-piece of the telescope, which at times is far above the base of the dome, was planned by Sir HOWARD GRUBB, of Dublin. This is an elevating floor 61½ feet in diameter, weighing 50,000 pounds, and is moved up and down through a space of 16 feet. It is highly probable that the present system will not be sufficiently powerful to raise the flooring rapidly enough, but in this event the hydraulic system can be altered, or steam or electricity substituted. The actual speed required can only be determined after a series of experiments have been made.

The dome for the 12-inch equatorial is 25 feet wide, weighs 8 tons, and its observing slit, which extends beyond the zenith, is 3 feet wide. The meridian-circle house is 43 by 38 feet. Its walls are double, the outer frame of galvanized iron, the inner one of California redwood. Between these is an air space 24 inches wide, which encircles the buildings. There is also an air space above the ceiling, which communicates with the room and with the air spaces of the walls, and on the west there is a ventilating tower two stories in height, which connects with the room of the meridian-transit instrument. By these means the temperature of the building is kept the same as that of the external air. The transit house, adjoining the meridian-circle house, is built of iron, with a wooden lining, and is arched by a curved shutter, which is controlled by levers, planned by Sir HOWARD GRUBB. The photographic observatory, north of the transit house, is a small wooden building, with brick foundation. The tube of the photoheliograph telescope enters this house, and a brick pier supports the photoheliograph. A room in the second floor of the main building is also fitted for photography.

The large telescope, which embodies the expressed object of the $700,000 donation, was mounted by WARNER & SWASEY, of Cleveland. The tube is nearly cylindrical, and is 60 feet in length. There are three finders, 6, 4, and 3 inches in aperture, and in addition to these the 12-inch equatorial can be quickly attached, as a pointer, for photographic work if the controlled driving clock does not work satisfactorily. The lens is 36 inches clear aperture, being the largest object glass in the world, and has a 678-inch focus. The flint disk was obtained from FEIL, in April, 1882, and after nineteen failures the crown-glass disk was cast successfully in September, 1885. The third photographic crown lens was purchased from FEIL in 1886, and broke while in the hands of the CLARKS. The trustees of Yale University then offered their 27-inch flint glass to the Lick Observatory, but this was too yellow, and in 1887 Mr. ALVAN G. CLARK bought in Paris, from FEIL, the crown glass which is worked into a third lens. In addition to its magnifying power and its perfect definition, *i. e.*, neatness, accuracy, etc., this telescope has great light-gathering power, and stars may be seen through it which are thirty thousand times fainter than the faintest seen by the naked eye, and the moon will appear under the same conditions as if it were seen by the naked eye at about 200 miles from the earth.

The 12-inch refractor, which was originally made for Dr. HENRY

DRAPER's private observatory at Hastings, N. Y., by **ALVAN CLARK & SONS**, is of the finest construction. The object-glass of the 6½-inch equatorial was also made by the **CLARKS**, and is provided with a portable mounting made by **WARNER & SWASEY**. The 4 inch comet-seeker, made by **ALVAN CLARK & SONS**, has a focal length of 33 inches. The rays fall on a reflecting prism, and are bent into a horizontal plane. The eye of the observer, moving in azimuth while the telescope is in altitude, can cover the whole sky. The motion is effected by turning a crank. This was bought on Professor **NEWCOMB**'s recommendation.

The photoheliograph is mounted south of the transit house. The transit instrument determines the axis of the photoheliograph, and this is also used as a collimator for the transit. The 6-inch **REPSOLD** meridian circle was delivered in 1881, after having been inspected by Professors **AUWERS** and **KRUEGER**, of Berlin. The declinograph was made under the supervision of Dr. **JOHANN PALISA**, of Vienna, to fit either a 12-inch or a 6 inch equatorial. The universal instrument made by **REPSOLD** consists of a telescope containing a prism, into which the rays of light are reflected. Its aperture is 2.15 inch. The horizontal circle reads by two microscopes to two seconds, and the circles are 10 inches in diameter. This is a perfect geodetic instrument, and together with a 6-inch equatorial and a chronometer can be easily packed for astronomical expeditions. There are several chronometers made by **NEGUS**, and a thermometric chronometer by **C. FRODSHAM**. The most important of the minor instruments are the filar micrometer for the 36-inch telescope by **FAUTH & CO.**, the duplex micrometer by **GRUBB**, and a star spectroscope made by **BRASHEAR** from designs of Mr. **KEELER**. Plans for a large solar spectroscope are being worked out by Professors **HOLDEN** and **LANGLEY**. The other instruments are a delicate sphereometer by **FAUTH & CO.**; resistance coils; galvanometers; a disk photometer; spectroscopes; a lever trier of refined construction; and an engine for measuring photographs, scales, etc., made by **STACKPOLE & BROS.**, from designs of Professor **HARKNESS**.

The meteorological instruments are: Self-registering rain-gauges, wind-gauges, barometers, and a number of thermometers. There is a complete set of apparatus for registering earthquakes, provided by the Cambridge Scientific Instrument Company, consisting of a horizontal seismograph with clock and driving plate, the clock being started by an electric contact at the beginning of a shock, and the two rectangular components of the horizontal motion then registering on a moving plate; a vertical seismograph to register vertical motions on a dial plate; a duplex pendulum seismograph to give independent records on a dial plate, the pencil being free to move in any azimuth; and a chronograph, which is set in motion at the beginning of an earthquake and records its duration upon a clock. The staff of the observatory consists of Prof. **EDWARD S. HOLDEN**, director and chief astronomer; **SAMUEL W. BURNHAM**, **JAMES E. KEELER**, **JOHN M. SCHAEBERLE**, and **EDWARD E. BARNARD**, assistant astronomers; and **C. B. HILL**, secretary, librarian, and occasional observer.

Early in 1886, Professor **HOLDEN** made contracts with the Southern Pacific and other railroad companies for supplying time from the observatory by automatic electric signals. This regular time service, of which Mr. **KEELER** has charge, has been in operation since January, 1887. A great part of the apparatus used in this service forms an integral part of the observatory's equipment. The system which has thus been introduced has been of great service to that particular section of the country, as well as to the railroad companies.

Instruments for recording earthquake shocks have been constructed by a company in San Francisco, and are sold at a very low figure. It is designed in this way that records of any seismic movements shall be procured by private individuals in different parts of the State, and plates upon which the movement has been recorded may be sent to the observatory, where a record will be kept of all such data, and blue prints will be made of the diagrams and copies of this sent to the person from whom the plate has been obtained. Although this is quite independent of the regular work of the observatory, it will doubtless lead to the accumulation of data which will be most important in formulating statistics for future use.

The great telescope has been mounted for several weeks, and several satisfactory tests of its capacity have been made. It was first directed to the sky on the evening of January 3, 1888, and a few observations were then made for the partial adjustment of the object-glass, but the observation was abbreviated by the skies becoming cloudy. The next observations made were on the evening of the 7th. On this occasion Saturn was observed, and Mr. KEELER, who conducted the observation, says with rapture that it was "the most glorious telescopic spectacle ever beheld." He exclaims: "Not only was he shining with the brilliancy due to the great size of the objective, but the minutest details of his surface were visible with wonderful distinctness."

MOUNT LOOKOUT, OHIO.

Cincinnati Observatory.

Longitude from Washington, $29^m\ 29.33^s$ W.

Latitude, 39° 8′ 20″ N.

Authority for longitude: Washington Observations for 1877. Appendix IV; for latitude: Preliminary reduction of unpublished Observations.

Directors: O. M. MITCHEL, 1842.
H. TWITCHEL, 1853.
W. DAVIS, 1854.
C. ABBE, 1869.
ORMOND STONE, 1875.
H. C. WILSON, 1882.

Founded in 1842 through the efforts of Professor MITCHEL.

The ground was donated by NICHOLAS LONGWORTH. Removed in 1873 to new building erected at Mount Lookout. The new grounds were donated by JOHN KILGOUR.

INSTRUMENTS:

(*b*) *Meridian transit instrument:* Makers, BUFF and BERGER; aperture, 3 inches; magnifying power, 100 diameters.

(*c*) *Equatorial instruments:* One made by UTZSCHNEIDER and FRAUENHOFER; finished by MERZ & MAHLER; object-glass refigured by ALVAN CLARK & SONS; aperture of objective, 11¼ inches; magnifying powers of eye-pieces, 90 to 1400. (*c′*) One by ALVAN CLARK & SONS; aperture, 4 inches; magnifying powers, 15 to 250.

(*f*) *Chronograph:* BOND

(*g*) *Clocks:* Two mean time; makers, ROBERT MOLYNEUX, JAMES RITCHIE & SON.

(*h*) *Chronometer:* Sidereal; makers, WILLIAM BOND & SON.

(*i*) *Miscellaneous:* Magnetic theodolite; maker, GAMBEY. Sextant; makers, STACKPOLE & BROTHER. Inclinometer time-ball, telegraphic apparatus, etc.

MIDDLETOWN, CONNECTICUT.

Observatory of Wesleyan University.

Longitude from Washington, ——.
Latitude, ——.
Director: Prof. J. M. VAN VLECK.

NEW BRUNSWICK, NEW JERSEY.

Observatory of Rutgers College.

Longitude from Washington, ——.
Latitude, ——.
Director: ——.

NASHVILLE, TENNESSEE.

Observatory of Vanderbilt University.

Longitude from Washington, $38^m\ 56^s$ W.
Latitude, 36° 10′ 01″ N.
Authority for longitude and latitude: U. S. Coast Survey.
Director: E. E. BARNARD.

INSTRUMENTS:

(*c*) *Equatorial instrument:* A simple equatorial; aperture of objective, 5 inches; magnifying powers of eye-pieces, 52 to 520. (*c′*) A small 2½ inches alt-azimuth telescope with good rack-work; all the eye-pieces of large telescope fit it.

(*i*) *Miscellaneous:* In use also a small instrument. The base of this instrument is divided to degrees and read by vernier to 3′ of arc. An upright pillar carries a semi-circle of altitude; this is divided to degrees and read to 3′ of arc by a vernier. Attached to the semi-circle of altitude is an hour-circle divided to 4^m of time and read to single minutes by vernier. Upon the hour-circle rests a semi-circle of declination divided to degrees and read to 3′ of arc by vernier. On the base are two levels, the instrument being leveled by three adjusting screws, which also serve as feet. The declination semi-circle carries a very small telescope about .4 inch diameter of objective. The telescope has a diagonal eye-piece with metal reflector and single lenses and vertical and horizontal hairs. The instrument was made by W. & S. Jones, London. It is used for identifying stars in comet observations by setting the altitude semi circle for the latitude, thereby converting the instrument into an equatorial.

NEW HAVEN, CONNECTICUT.

Winchester Observatory of Yale College.

Longitude from Washington, $0^h\ 16^m\ 30.1^s$ E.
Latitude, 41° 18′ 36.5″ N.
Authority for longitude: U. S. Coast Survey. For latitude: Zenith telescope observations in 1857–'58. (See Am. Jour. of Sci., vol. 30, p. 52, second series.) Coast Survey latitude, 41° 18′ 10″ 67 N.

Directors: E. LOOMIS, 1831.
D. OLMSTEAD, 1836.
C. S. LYMAN, 1847.
H. A. NEWTON.

The *horological bureau* is a department of the Winchester Observatory organized in January, 1880, with a special equipment of instruments for a regular and extended public time service. The standard time by law of the State is that of the meridian of the city hall, New York, which is $4^m\ 19.6^s$ slow of New Haven and $12^m\ 10.5^s$ fast of Washington. Another important work of the bureau is the testing of watches and chronometers in the interest of the watch manufacture, for which hot and cold closets and other special facilities are provided.

There is also connected with the observatory a *thermometrical bureau*, in charge of DR. WALDO, for the verification of clinical and other thermometers.

INSTRUMENTS:

(*a*) *Meridian circle:* Makers, ERTEL & SONS, 1845. Formeriy the property of the U. S. Naval Observatory. Altered by WILLIAM J. YOUNG, 1855, and regraduated 1876. Diameter of circles, 40 inches; divided to 2′; read by six microscopes to 1″; aperture of objective, 3.8 inches; for observations of the sun, aperture employed, 1.7 inches; magnifying power ordinarily employed, 190 diameters; focal length, 58.2 inches.

(*b*) *Meridian transit instruments:* One made by C. S. LYMAN, of 36-inch focal length; aperture, 2.6 inches; magnifying power, 185 diameters. Circle, 12 inches, reading to 10″ by verniers; it has declination micrometer and fine level, for use as zenith telescope, made in 1852–'53. One by TROUGHTON & SIMMS, London; aperture, 3.99 inches; magnifying power, 150–200 diameters; focal length, 5.108 feet. (*b′*) Combined transit and zenith telescope, 36-inch focal length; aperture, 2.6 inches; power, 185 diameters; 12-inch circle, reading to 10″ by verniers; declination micrometer and sensitive level for latitude work; made in 1852–'56: object-glass by FITZ, design and mounting by C. S. LYMAN.

(*c*) *Equatorial instruments:* Makers, ALVAN CLARK & SONS; aperture of objective, 9 inches; magnifying powers of eye-pieces, 40, 80, 140, 200, 280, 450, 620. (*c′*) Portable 4⅔-inch refractor by Messrs. CLARK & SONS.

(*d*) *Spectroscope:* By A. **Clark & Sons**, of 7 prisms twice traversed.

(*f*) *Chronographs:* One by A. **Clark & Sons**, with conical pendulum governor; another by **William Bond & Sons**, Boston, with **Bond's** spring governor.

(*g*) *Clocks:* One mean time, made by E. **Howard & Co.**, Boston; one by **William Hillhouse**, New Haven; one sidereal, by **William Bond & Son**, Boston; one by **Appleton**, London; one by E. **Howard & Co.**

(*h*) *Chronometers:* One pocket chronometer, mean time, by **Johnson**, London; one sidereal, by **Pool**, London, improved by **Negus**, New York.

(*i*) *Miscellaneous:* Two bifilar position-micrometers, one by **Dollond**, the other by **Fauth & Co.**, Washington, D. C.; a patent sextant and a patent reflecting circle, by **Pistor & Martins**, Berlin; repeating relays, sounders, etc., for time service. Yale College has also in use a 5-inch 10-foot refractor by **Dollond**, a sidereal clock, and a 20-inch transit instrument, in charge of Professor **Loomis**.

NEW ORLEANS, LOUISIANA.

Observatory.

Longitude from Washington,
Latitude, 29° 57′ 26″ N.
Authority for longitude and latitude: U. S. Coast Survey, 1859, p. 265; Connaissance des Temps, Paris, 1884, p. lx.
Director: ———.

NEW WINDSOR, ILLINOIS.

Private Observatory.

Longitude from Washington, $53^m\ 53^s$ W.
Latitude, 41° 13′ N., approximately.
Authority for longitude: telegraphic time signals direct from U. S. Naval Observatory at Washington on December 4, 5, 6, 7, 1882; for latitude, own determination.
Director: **Edgard L. Larkin.**

Permanent observatory; brick pier and revolving dome.

INSTRUMENTS:

(*c*) *Equatorial instrument:* Makers, **Alvan Clark & Sons**; aperture of objective, 6 inches; magnifying powers of eye-pieces, 27, 60, 130, 250, 300, 600, with prism and solar eye-piece. Two of the eye-pieces are **Gundlach's** periscopic.

(*g*) *Clock:* Sidereal; ordinary clock.

(*i*) *Miscellaneous:* Planisphere, charts, maps, and catalogues.

NEWINGTON, CONNECTICUT.

Private Observatory.

Longitude from Washington, $21^m\ 25^s$ E.
Latitude, 41° 44′ N.
Authority for longitude and latitude: difference from Hartford state-house, Coast Survey.
Director: D. W. EDGECOMB.

This observatory consists of a small frame building, with dome 12 feet 6 inches diameter, upon the grounds of the owner, covering an equatorial telescope.

INSTRUMENTS:

(*c*) *Equatorial instrument:* Makers, A. CLARK & SONS; aperture of objective, 9.4 inches; magnifying powers of eye-pieces, various up to 2,000.

(*g*) *Clock:* Mean time; Swiss regulator; seconds.

NEW YORK, NEW YORK.

I. *Columbia College Observatory.*

Longitude from Washington, $12^m\ 18.4^s$ E.
Latitude, 40° 45′ 23.1″ N.
Authority for longitude and latitude: these constants were calculated from data furnished by city surveyors and based on the position of Mr. Rutherfurd's observatory. The longitude and latitude of the latter were determined by the Coast Survey.
Director: J. K. REES.

The old observatory has been torn down and a new observatory has been erected within a few feet of the old site.

II. *Private Observatory.*

Longitude from Washington, $12^m\ 15.47^s$ E.
Latitude, 40° 43′ 48.53″ N.
Authority for longitude and latitude: U. S. Coast Survey party (1859), with zenith telescope upon 24 pairs of stars, and telegraphic communication with Washington and Cambridge.
Director: L. M. RUTHERFURD.

INSTRUMENTS:

(*b*) *Meridian transit instrument:* Maker, STACKPOLE; aperture 3 inches. Only used for time.

(*c*) *Equatorial instrumemt:* Makers, Messrs. RUTHERFURD & FITZ; aperture of objective, 13 inches. The telescope has been employed mostly in photographing the sun, moon, and groups of stars.

(*f*) *Chronograph:* MORSE.

(*g*) *Clock:* Sidereal; maker, DENT.

NORTHFIELD, MINNESOTA.

Carleton College Astronomical Observatory.

Longitude from Washington, $1^h\ 4^m\ 23.85^s$ W.
Latitude, 44° 27′ 40.77″ N.
Authority for longitude: longitude depends on exchange of telegraphic signals between Coast Survey office at Saint Paul and director at Northfield. Authority for latitude: zenith telescope observations of 40 pairs of stars reduced to apparent places from Safford's catalogue.
Director: WILLIAM W. PAYNE.

Completed in 1878. Attached to Carleton College, central building, 6 meters long, surmounted by a dome, with two wings, one used for meridian instruments, the other for the library.

INSTRUMENTS:

(*b*) *Meridian transit instruments:* Makers, FAUTH & CO.; aperture, 3 inches; magnifying powers, 60, 70, and 80 diameters.

(*c*) *Equatorial instruments:* Makers, A. CLARK & SONS; aperture of objective, 8¼ inches; magnifying powers of eye-pieces, 50, 100, 200, 400, 800. (*c′*) Portable equatorial: maker, JOHN BYRNE, of New York; aperture of objective, 4.3 inches.

(*f*) *Chronograph:* One, made by A. CLARK & SONS.

(*g*) *Clocks:* One mean time; makers, E. HOWARD & CO., No. 196; one sidereal; makers, E. HOWARD & CO., No. 195.

(*h*) *Chronometer:* Sidereal; makers, BOND & SONS, No. 374.

(*i*) *Miscellaneous:* The observatory has been favored by the loan of a good zenith telescope for several months from Lieut. EDWARD MAGUIRE, chief engineer in the department, with headquarters at Saint Paul. The large equatorial is provided with micrometer, with a full battery of eye-pieces.

OMAHA, NEBRASKA.

Creighton College Observatory.

Longitude from Washington, ———.
Latitude, ———.
Director: ———.

(NEAR) OXFORD, MISSISSIPPI.

Observatory of the University of Mississippi.

Longitude from Washington, $49^m\ 55.03^s$ W.
Latitude, 34° 22′ 12.64″ N.
Authority for longitude and latitude, R. B. FULTON.
Director: R. B. FULTON.

The observatory was erected in 1876.

Instruments:

(*a*) *Altitude-azimuth:* Makers, Lerebours & Secretan; diameter of circles, 10 inches; divided to 10′; read by 4 microscopes to 10″; aperture of objective, 1½ inches.

(*b*) *Meridian transit instrument:* Makers, B. Pike & Sons; aperture, 2¼ inches.

(*c*) *Equatorial instrument:* Maker, Merz, of Munich; aperture of objective, 4½ inches; magnifying powers of eye-pieces, 96 to 312 diameters.

(*d*) *Spectroscope:* Kirchoff's 4-prism table spectroscope.

(*g*) *Clock:* Mean time; makers, Ritchie & Sons, Boston.

(*h*) *Chronometer:* Sidereal; makers, William Bond & Son, Boston.

PHELPS, NEW YORK.

Red House Observatory.

Longitude from Washington, 12^s W.
Latitude, 42° 58′ N.
Director: William R. Brooks.

Instruments:

(*c*) A silver-glass reflecting telescope of 5 inches aperture and 50 inches focal length, mounted as a Newtonian on alt-azimuth stand. A 2-inch reflector, 36 inches focus. Both made by the director.

(*g*) *Clock:* Mean time; makers unknown; marine.

PHILADELPHIA, PENNSYLVANIA.

Central High School Observatory.

Longitude from Washington, 7^m $33^s.64$ E.
Latitude, 39° 57′ 7.5″ N.
Director: M. B. Snyder.

POUGHKEEPSIE, NEW YORK.

Vassar College Observatory.

Longitude from Washington, 12^m 38.5^s E.
Latitude, 41° 41′ 18″ N.
Director: Maria Mitchell.

Observatory was built in 1865.

Instruments:

(*a*) *Meridian circle:* Maker, Young, of Philadelphia; aperture of objective, 3¾ inches.

(*c*) *Equatorial instrument:* Object-glass by Clark; aperture of objective, 12⅓ inches; magnifying power of eye-pieces, 200 to 600+.

(*f*) *Chronograph:* One.

(*g*) *Clock:* One sidereal; makers, BOND & SON.

(*h*) *One chronometer:* Mean time; makers, BLISS & CREIGHTON.

(*i*) *Miscellaneous:* Small telescopes; one by CLARK & SONS; aperture, 3 inches.

PRINCETON, NEW JERSEY.

Observatories of the College of New Jersey.

I. *Halstead Observatory.*

Longitude from Washington, 9m 32.60s E.
Latitude, 40° 20′ 55.8″ N.
Director: Prof. C. A. YOUNG.

Situated at the western extremity of the college campus, and about half a mile west of the School of Science observatory.

The large telescope has been placed in position. The required funds have been subscribed by the friends of the college, ROBERT BONNER, of New York, R. L. STUART, and the trustees of the JOHN C. GREEN estate being the largest contributors.

The iron dome under which it is mounted is 39 feet inside diameter, and very heavy. A 4-horse gas-engine in the basement furnishes the power for moving it and managing the shutter. It is possible to raise the shutter, turn the dome to any part of the sky, and have the telescope pointed upon any designated object within five minutes after entering the building. The same engine drives a small Edison dynamic machine, which supplies electric light to all parts of the observatory and furnishes electric currents for spectroscopic work.

II. *Observatory of the John C. Green School of Science.*

Longitude from Washington, 9m 34.54s E.
Latitude, 40° 20′ 57.8″ N.
Director: Prof. C A. YOUNG.

The establishment is designed for purposes of instruction, and devoted almost entirely to that object.

PROVIDENCE, RHODE ISLAND.

Seagrave Observatory.

Longitude from Washington, 22m 34.51s E.
Latitude, 41° 49′ 46.40″ N.
Authority for longitude and latitude: United States Coast Survey, and ourselves, F. E. SEAGRAVE and LEONARD WALDO.
Director: F. E. SEAGRAVE.

INSTRUMENTS:

(c) *Equatorial instrument:* One equatorial; makers, ALVAN CLARK & SONS; aperture of objective, 8¼ inches; magnifying powers of eyepieces, 93, 121, 184, 311, 571; negatives, 518, 116, 230, 335, 375; positive eye-pieces achromatic, 248.

(d) *Spectroscope:* One by BROWNING, which consists of 4 whole and 2 half prisms of 60°; flint glass; gives a dispersive power of ten prisms by reflection.

Chronometer: Sidereal; maker, VICTOR KULLBERG, London.

RIVERDALE, NEW YORK.

Private Observatory.

Longitude from Washington, ———.
Latitude, ———.
Director: WILLIAM MEIKLEHAM.

Observatory was removed from Fordham, N. Y.

INSTRUMENTS:

(c) *Equatorial instrument:* Maker, JOHN BYRNE, of New York; aperture of objective, $4\frac{3}{10}$ inches; focal distance, 65 inches; magnifying powers of eye pieces, 20, 30, 45, 60, 80, 150, 250, 300, 350, and 450; also an amplifier, which doubles each of these powers when used. Attached to the telescope is a finder of 1½ inches aperture, magnifying 20 diameters. Right ascension circle divided to read to 4 seconds of time; declination circle divided to read to 1′ of arc. Both circles divided on silver and read by microscopes attached thereto. Driving clock.

(d) *Spectroscope:* One.

(g) *Clock:* Mean time; maker, SETH THOMAS, SONS & CO.

(i) *Miscellaneous:* Filar micrometer; divided on silver to measure 0″.3 of arc in distance and 6′ in position, with suitable eye-pieces and illuminating apparatus.

ROCHESTER, NEW YORK.

Warner Observatory.

Longitude from Washington, $3^m\ 8^s$ W.
Latitude, 43° 8′ 15″ W.
Authority for longitude and latitude: Signal Service Officer.
Director: LEWIS SWIFT.

INSTRUMENTS:

(c) *Equatorial instrument:* Makers, ALVAN CLARK & SONS (constructing); aperture of objective, 16 inches; magnifying powers of eyepieces, from 45 to 2000. (c′) Altitude-azimuth, 4½ inches, by FITZ; powers from 25 to 432. Telescope 4½-inch refractor, originally by FITZ, but since last report the flint lens of the objective was unfortunately broken; it has been replaced by **ALVAN CLARK & SONS**. Its performance, which was always good, appears to be rather better than before the accident.

SAINT LOUIS, MISSOURI.

Observatory of Washington University.

Longitude from Washington, $52^{m}\ 37.02^{s}$ W.
Latitude, 38° 38′ 3.64″ W.
Authority for longitude and latitude: A pier about 150 feet away from the observatory pier was located by **EIRNBECK** in 1870. The longitude has again been determined by a Coast Survey party.
Directors: J. K. **REES**, 1877.
H. S. **PRITCHETT**, 1881.

INSTRUMENTS:

(*b*) *Meridian transit instrument:* Maker, **WÜRDEMANN**; aperture, 2.65 inches; magnifying power, 90 diameters, with micrometer attachment.

(*c*) *Equatorial instrument:* Maker, H. **FITZ**, of New York City; aperture of objective, 6¼ inches; magnifying powers of eye-pieces, 76, 125, 190, 305, and 456 diameters. (*c′*) *Finder:* $2\frac{3}{100}$ inches aperture; magnifying power, 23 diameters.

(*d*) *Spectroscope:* One single prism **BROWNING** spectroscope.

(*e*) *Photometer and other subsidiary apparatus:* Filar position, micrometer attached; clock-work for moving telescope.

(*g*) *Clock:* Mean time; common tower clock.

(*h*) *Chronometer:* Mean time; makers, (1) **DENT** No. 2749, (2) **BLACKIE** No. 789.

(*i*) *Miscellaneous:* Sextant, by **BLUNT**, of New York City.

SOUTH BETHLEHEM, PENNSYLVANIA.

Sayre Observatory of Lehigh University.

Longitude from Washington, $6^{m}\ 40.19^{s}$ E.
Latitude, 40° 36′ 23.89″ N.
Director: C. L. **DOOLITTLE**.

Founded in 1877, in connection with Lehigh University.

INSTRUMENTS:

(*c*) *Equatorial instrument:* Makers, **CLARK & SONS**; aperture of objective, 6 inches; magnifying powers of eye-pieces, 12 to 225.

(*g*) *Clock:* Sideral; makers, **BOND & SON**.

(*i*) *Miscellaneous:* A portable transit instrument by **STACKPOLE**, a zenith telescope by **BLUNT**, and a prismatic sextant by **PISTOR & MARTIN**.

SOUTH HADLEY, MASSACHUSETTS.

Observatory of Mount Holyoke Seminary.

Longitude from Washington, $17^m\ 51.75^s$ E.
Latitude, 42° 15′ 18.2″ N.
Authority for longitude: R. H. WEST, by telegraphic communication with Cambridge at the time of the transit of Venus. For latitude: C. A. YOUNG, by zenith telescope method.
Director: Miss E. M. BARDWELL.

Through the liberality of Mr. A. L. WILLISTON, of Northampton, the seminary has recently been enabled to erect a small but very complete astronomical observatory, supplied with all the necessary instruments. It is designed to furnish the means for instruction to any who may wish to make the subject a specialty, and to give opportunity to any of the teachers or post-graduates who may take an interest in astronomy to make observations of real value.

The building, of wood, consists of a tower with a dome 18 feet in diameter, flanked by two wings, one extending to the east and one to the north. The dome is very light, and rotates so easily that even the feeblest of the young ladies can manage it without difficulty. The arrangements for opening and closing the shutters which cover the slit in the dome, and the openings for the transit and prime vertical instrument, are worked with equal facility. In the dome is mounted a fine 8-inch equatorial by CLARK, completely fitted out with clock-work, finding-clock, micrometers, spectroscope, solar eye-piece, etc., and so arranged that the circles can be read and the clamps and tangent screws worked from the eye-piece of the instrument.

The object-glass is almost entirely the work of the senior ALVAN CLARK, and is one of the most perfect specimens of his art.

In the transit-room is mounted a meridian circle by FAUTH & Co., of Washington. The instrument has a telescope of 3 inches aperture, and circles of 16 inches diameter, reading to seconds by two microscopes. It has a reversing apparatus, and is fitted with a "latitude level" and micrometer, so that it can, if desired, be used as a zenith telescope. A large collimator is mounted upon a pier south of it, and in a corner of the room is a clock with DENISON escapement, also by FAUTH & Co., as is the chronograph, which is mounted in an adjoining closet. The Observatory possesses also a sextant and artificial horizon and a set of meteorological apparatus.

There is no instrument in the prime vertical room (which is used mainly as a waiting-room or for recitations), but it is provided with a pier and shutter, so that the meridian circle can be set up there if it is ever thought desirable to make observations in that plane.

SPICELAND, INDIANA.

Private Observatory.

Longitude from Washington, 33^m 30^s. W. (approximately).
Latitude, 39° 50′ N. (approximately).
Director: WILLIAM DAWSON.

TARRYTOWN, NEW YORK.

Private Observatory.

Longitude from Washington, 12^m 47.16^s E.
Latitude, 41° 04′ 21″ N.
Authority for longitude and latitude: United States Coast Survey.
Director: CHARLES H. ROCKWELL.

INSTRUMENTS:

(*c*) *Equatorial intrument:* makers,—glass, Dr. C. S. HASTINGS;—mounting, JOHN BYRNE; aperture of objective, 6¼ inches; magnifying powers of eye-pieces, 60, 112, 170, 243, 327, 409, 751.

TROY, NEW YORK.

Williams Proudfit Observatory.

Longitude from Washington, 13^m 27.5^s E.
Latitude, 42° 43′ 52″. 89 N.
Authority for longitude and latitude: Longitude by electro-magnetic signals from United States Naval Observatory. Latitude determined by observations with the zenith telescope.
Director: Prof. DASCOM GREENE.

INSTRUMENTS:

(*b*) *Meridian transit instruments:* Makers,—one by E. KÜBEL, Washington; aperture, 2.5 inches; magnifying power, 60 diameters.

(*b′*) Makers, PHELPS & GURLEY, Troy; aperture, 2 inches; magnifying powers, 30 diameters.

(*c*) *Equatorial instruments:* Maker, HENRY FITZ, New York; aperture of objective, 3.5 inches; magnifying powers of eye-pieces, 45 to 200 diameters.

(*g*) *Clocks:* Mean time; makers, STOKELL, New York; and HOWARD, Boston.

(*h*) *Chronometers:* Sidereal; maker, J. FLETCHER, London.

(*i*) *Miscellaneous:* Sextant; TROUGHTON & SIMMS, London.

VEVAY, INDIANA.

Private Observatory.

Longitude from Washington, ———.
Latitude, ———.
Director: CHAS. G. BOERNER.

UNIVERSITY OF VIRGINIA.

Leander McCormick Observatory.

Longitude from Washington, $5^m 53.13^s$ W.
Latitude, 38° 2′ 1.2″ N.
Director: ORMOND STONE.

WASHINGTON, DISTRICT OF COLUMBIA.

United States Naval Observatory

Longitude from Greenwich, $5^h 8^m 12.09^s$ W.
Latitude, 38° 53′ 38.8″ N.
Directors: M. F. MAURY, 1841.
JAMES M. GILLISS, 1861.
CHARLES H. DAVIS, 1865.
BENJAMIN F. SANDS, 1867.
JOHN RODGERS, 1874.
STEPHEN C. ROWAN, 1882.
ROBERT W. SHUFELDT, 1883.
SAMUEL R. FRANKLIN, 1884.
GEORGE E. BELKNAP, 1885.
ALLAN D. BROWN, 1886.
ROBERT L. PHYTHIAN, 1886.

Created by the Navy Department in 1833.

INSTRUMENTS:

(*a*) *Meridian circles:* 1; makers, PISTOR & MARTINS; diameter of circles, 43.40 inches; divided to 2′; read by 4 microscopes to 0″.1; aperture of objective, 8.52 inches; for observations of the sun, aperture employed, 3 inches; magnifying power ordinarily employed, 186 diameters.

(*b*) *Meridian transit instruments:* Makers, ERTEL & SON, aperture 5.33 inches; magnifying powers 85, 86, 106, 118, 162.

(*b′*) Eight portable transits and zenith telescopes combined, used on Transit of Venus Expeditions.

(*c*) *Equatorial instruments:* Makers, ALVAN CLARK & SONS; aperture of objective, 26 inches; magnifying powers of eye-pieces, 176 to 1800.

(*c′*) Made by MERZ: 9.62 inches aperture; powers, 90–900.

(*c″*) Eight 5-inch equatorials by ALVAN CLARK & SONS, used on Transit of Venus Expeditions.

(*e*) *Photometers:* One nebula-photometer (Hastings' pattern) for use with the 26-inch equatorial.

(*f*) *Chronographs:* Some 10 or 12 in all, of various kinds.

(*g*) *Clocks:* Mean time, 2; sidereal, 6.

(*h*) *Chronometers:* Mean time, all the chronometers of the United States Navy are kept here. Sidereal, eight, by NEGUS.

WEST POINT, NEW YORK.

West Point Observatory.

Longitude from Washington, 12m 22.71s E.
Latitude, 41° 23′ 31″ N.
Director: Col. P. S. MICHIE, Ph. Dr.

No regular work is done at this observatory beyond the practical instruction of the cadets in the use of the various instruments and the solution of the usual problems connected with the determination of latitude, longitude, time, etc., and work for local time, and local coordinates.

In 1882 a fine and permanent observatory was erected, designed to combine the latest and most improved observatory plans and to be equipped well, and intended to be a regular working observatory.

WILLETS POINT, NEW YORK.

Field Observatory—Engineer School of Application.

Longitude from Washington, 13m 04.39s ± 0.14s.
Latitude, 40° 47′ 21.59″ N. ± 0.08″.
Authority for longitude and latitude: Longitude determined by telegraphic time-signals from United States Naval Observatory, Washington; latitude determined by observations with zenith telescope.
Director: General HENRY L. ABBOT.

INSTRUMENTS:

(b) *Meridian transit instruments (four):* One; makers, LINGKE & CO., Silesia; aperture, 2½ inches; magnifying power, — diameters; focal length, 30 inches. One, Russian transit, aperture, 2.6 inches; STACKPOLE & BRO., New York; focal length, 30 inches. One, TROUGHTON, aperture, 2 inches; TROUGHTON, London; focal length, 30 inches. One, STACKPOLE; aperture, 2 inches; STACKPOLE & BRO., New York; focal length, 24 inches.

(c) *Equatorial instrument:* Makers, FAUTH & CO., Washington; aperture of objective, 5½ inches; magnifying powers of eye-pieces, assorted.

(f) *Chronographs:* HIPP'S; NEGUS-MORSE register.

(h) *Chronometers:* One mean time; makers, ARNOLD & DENT. One sidereal; makers, LUKENS, BOND & SON. Both break-circuit.

(i) *Miscellaneous:* One portable telescope, equatorially mounted; one zenith telescope—WILLIAM WÜRDEMANN; two sextants, STACKPOLE & BRO.; one personal equation machine; one barometer, GREEN'S cistern.

WILLIAMSTOWN, MASSACHUSETTS.

Field Memorial Observatory.

Longitude from Washington, $15^m\ 18.6^s$ E.
Latitude, 42° 42′ 49″ N.
Director: TRUMAN HENRY SAFFORD, Ph. D.

YPSILANTI, MICHIGAN.

State Normal School Observatory

Longitude from Washington, $26^m\ 10^s$ W.
Latitude, 42° 13′ N.
Authority for longitude and latitude, J. C. WATSON.
Director: LEWIS MCLOUTH, M. A.

INSTRUMENTS:

(*b*) *Meridian transit instrument:* Maker, GURLEY, Albany; aperture, 1½ inches; magnifying power, 30 diameters.

(*c*) *Equatorial instrument:* Maker, A. CLARK, Cambridgeport, Mass.; aperture of objective, 4 inches: magnifying powers of eye-pieces, 45, 90, 144, 210.

(*d*) *Spectroscope:* BROWNING, London, 2 prism.

(*h*) *Chronometer:* Sidereal; maker, NEGUS.

II. FOREIGN OBSERVATORIES.

ABERDEEN, SCOTLAND. (See DUN ECHT.)

ADELAIDE, SOUTH AUSTRALIA.

Observatory Branch of Post and Telegraph Department.

Longitude from Greenwich, $9^h\ 14^m\ 20.4^s$ E.
Latitude, 34° 55′ 33.8″ S.
Director: C. TODD, 1860.

ALGIERS, ALGERIA.

Observatoire National.

Longitude from Greenwich, $12^m\ 17^s$ E.
Latitude, 36° 44′ N.
Authority for longitude and latitude, A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Director: C. TRÉPIED.

ALTONA, PRUSSIA.

Sternwarte.

Longitude from Greenwich, $39^m\ 46.35^s$ E.
Latitude, 53° 32′ 45.3″ N.
Authority for longitude and latitude, Connaissance des Temps, 1884, p. xx.
Directors: H. C. SCHUMACHER, 1816.
A. C. PETERSEN (transient), 1851.
P. A. HANSEN, 1852.
C. A. F. PETERS, 1855.

Built in 1815; transferred to KIEL in 1873. (See Kiel.)

ANTWERP, BELGIUM.

Observatoire.

Longitude from Greenwich, $17^m\ 38.6^s$ E.
Latitude, 51° 12′ 28″ N.
Authority for longitude and latitude, A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Director: A. DE BOË.

ARMAGH, IRELAND.

Observatory.

Longitude from Greenwich, $26^{m}\ 35.5^{s}$ W.
Latitude, 54° 21′ 12.7″ N.
Authority for longitude and latitude, Connaissance des Temps, 1884, p. xiii.
Directors : J. A. Hamilton, 1792.
T. R. Robinson, 1825.

ASHURT, ENGLAND.

Observatory.

Longitude from Greenwich, $1^{m}\ 16^{s}$ W.
Latitude, 51° 15′ 58″ N.
Authority for longitude and latitude, Connaissance des Temps, 1884, p. xiii.

ATHENS, GREECE.

Observatory.

Longitude from Greenwich, $1^{h}\ 34^{m}\ 55.7^{s}$ E.
Latitude, 37° 58′ 20″ N.
Directors : G. C. Bouris, 1844.
J. F. J. Schmidt, 1858.

The observatory is an establishment of Baron Georg von Sina at Vienna. At the wish of the first Athenian astronomer, Professor Bouris, Baron Prokerch von Osten, the Austrian embassador at the Grecian court, by his influence, had favored the project, and on the 8th of July, 1842, during the great eclipse of the sun, King Otto laid the first brick on the Hill of the Nymphs, the northern extremity of the Hills of Onyx, northwesterly of the Akropolis, in an isolated situation, 105 meters above the level of the sea.

The founder of this establishment, Georg von Sina, died in May, 1856. His son, Simon, Baron von Sina, became the protector, and on May 15, 1858, appointed J. F. Julius Schmidt as astronomer, and on the 16th of December, 1858, as director:

BAMBERG, BAVARIA.

Sternwarte, C. Remeis.

Longitude from Greenwich, $43^{m}\ 32^{s}$ E.
Latitude, 49° 53′ 28″ N.
Director : E. Hartwig.

BARNET, ENGLAND.

Arkley House Observatory (Private.)

Longitude from Greenwich, ——.
Latitude, ——.
Proprietor: J. CAMPBELL.

BASEL, SWITZERLAND.

Physikalisches Institut, Bernoullianum.

Longitude from Greenwich, 30^m 20^s E.
Latitude, 47° 33′ 40″ N.
Director: ED. HAGENBACH-BISCHOFF, 1874.

The institute was founded in 1874, and the astronomical instruments were mounted in 1878.

INSTRUMENTS:

(*a*) The *Meridian circle*, constructed by the Société Genevoise, with 2½-inch objective, by C. A. STEINHEIL.

(*c*) The *Equatorial* made by the "Société Genevoise pour la construction d'instruments de physique" mounted on an isolated pillar, under a movable dome of 16½ feet (5 meters) diameter. The instrument is provided with a centrifugal regulator, constructed according to Prof. M. THURY's directions, with position micrometer, spectroscope, and camera obscura.

(*d*) *Spectroscope.*

(*g*) The *astronomical clock* was constructed by THEODOR KNOBLICH, in Hamburg.

The mean time is given by means of an electric pendulum, by M. HIPP, in Neuenburg.

Both clocks connect with a number of dials in various rooms, and also with the chronograph.

BASSES-PYRÉNNÉES, FRANCE.

M. D'Abbadie's Observatoire.

Longitude from Greenwich, ——.
Latitude, ——.
Director: ——.

BEDFORD, ENGLAND.

Observatory.

Longitude from Greenwich, 11^m 13^s W.
Latitude, 52° 8′ 28″ N.
Authority for latitude and longitude, Connaissance des Temps, 1884, page xiii.
Director: ——.

BENARES, INDIA.

Observatory.

Longitude from Greenwich, $5^h\ 22^m\ 31^s$ E.
Latitude, 25° 18′ 33″ N.
Authority for longitude and latitude: Connaissance des Temps, 1884, page xxxviii.
Director: ———.

BERGEN, NORWAY.

Naval Observatory.

Longitude from Greenwich, $21^m\ 13^s$ E.
Latitude, 60° 23′ 54″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Directors: C. F. G. BOHR, 1818.
J. J. ÅSTRAND, 1833.

Founded in 1788. Has only been used to furnish standard time.

BERLIN, PRUSSIA.

Königliche Universitäts Sternwarte.

Longitude from Greenwich, $53^h\ 34^m\ 91^s$ E.
Latitude, 52° 30′ 16.7″ N.
Authority for longitude and latitude: [LOEWY and LE CLERK] Connaissance des Temps., 1884, p. xxvi.
Directors: G. KIRCH, 1706.
J. H. HOFFMANN, 1710.
C. KIRCH, 1717.
J. W. WAGNER, 1740.
H. N. GRISCHOW, 1745.
J. KIES, 1754.
F. U. S. ALPINUS, 1755.
J. J. HUBER, 1756.
JEAN BERNOULLI, 1767.
J. E. BODE, 1786.
J. F. ENCKE, 1825.
W. J. FOERSTER, 1865.

Founded at the request of LEIBNITZ in 1705; completed in 1711. Originally situated in the suburb Dorotheenstadt, in the northern part of the city. A great square tower of five stories, 46 feet in length and 88½ feet in height. This observatory was re modelled in 1787 and again in 1800. In 1833 a new observatory was built at the southern extremity of the Charlotten strasse. It was here that GALLE discovered Neptune in 1846. The Astronomische Jahrbuch has been published annually since 1776.

BERN, SWITZERLAND.

Sternwarte.

Longitude from Greenwich, 29^m 45.66^s E.
Latitude, 46° 57′ 8.7″ N.
Directors: F. TRECHSEL, 1821.
R. WOLF, 1847.
J. KOCH, 1856.
H. WILD, 1859.
A. J. T. FORSTER, 1871.

Constructed upon a bastion in 1821. In plan a regular octagon, the circle described about which has a diameter of 65½ feet (20 meters).

BESANÇON, FRANCE.

Observatoire.

Longitude from Greenwich, 23^m 57.5^s E.
Latitude, 47° 14′ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Director: L. J. GRUEY.

BILK, PRUSSIA. (See DÜSSELDORF.)

BIRR CASTLE, IRELAND.

Parsonstown Observatory.

Longitude from Greenwich, 31^m 40.9^s W.
Latitude, 53° 5′ 47″ N.
Director: The EARL OF ROSSE.

INSTRUMENTS:
The celebrated 60-foot reflecting telescope, with a 6-foot speculum.

BLENHEIM PARK, OXFORD COUNTY, ENGLAND.

Observatory.

Longitude from Greenwich, 5^m 26^s W.
Latitude, 51° 50′ 28″ N.
Authority for longitude and latitude: Connaissance des Temps, 1884, p. xiii.
Director: ———.

BOGOTÁ, UNITED STATES OF COLOMBIA.

I. *Observatorio Astronómico Nacional.*

Longitude from Greenwich, $4^h\ 56^m\ 59^s$ W.
Latitude, 4° 35′ 48″ N.
Directors: FRANCISCO JOSÉ DE CALDOS, 1805–1810.
BENEDICTO DOMINGUEZ, 1837.
INDALECIO LIEVANO, 1862.
JOSÉ M. GONZALES BENITO, 1867.

The observatory was built in 1803 under the auspices of the Viceroy Don PEDRO MENDIMETA and the botanist MUTIZ, according to the plans of DOMINGO PETRES. From 1810 to 1837 it was abandoned. It was finally reorganized in 1881, by order of the President of the Republic, RAFAEL NUÑEZ, by JOSÉ M. GONZALES BENITO, its present director.

II. *Observatoire Flammarion.*

Founded in 1881 by JOSÉ M. GONZALES BENITO, director of the National Observatory of Bogotá, in honor of CAMILLE FLAMMARION. It is built in the private dwelling of M. Gonzales.

BOLOGNE, ITALY.

Observatorio Astronomico.

Longitude from Greenwich, $45^m\ 24.9^s$ E.
Latitude, 44° 29′ 47″ N.
Director: A. SAPORETTI.

BOMBAY, INDIA.

Government Observatory at Colaba.

Longitude from Greenwich, $4^h\ 51^m\ 12.09^s$ E.
Latitude, 18° 53′ 45″ N.
Director: CHARLES CHAMBERS.

The principal work of the Colaba observatory is in the fields of terrestrial magnetism and meteorology, and astronomical observations are made only for the practical purpose of time-keeping, partly for the public service and partly for the use of the observatory.

BONN, PRUSSIA.

I. *Universitäts Sternwarte.*

Longitude from Greenwich, $28^m\ 23.29^s$ E.
Latitude, 50° 43′ 45″ N.
Authority for longitude and latitude: [LE CLERK and BENARDIÈRES] Connaissance des Temps, 1884, p. xxvi.
Directors: K. D. VON MÜNCHOW, 1818.
F. W. A. ARGELANDER, 1837.
E. SCHÖNFELD, 1875.

Founded in 1818, near the university. The erection of a more complete observatory was decided upon in 1837, and the new establishment was finished in 1840. It includes two halls for meridian instruments and five turrets. Here it was that the review of the heavens, known under the name of *Durchmusterung*, was undertaken and accomplished under the direction of ARGELANDER, including all stars up to the ninth magnitude.

II. *Photometrisches Observatorium.*

Longitude from Greenwich, ——.
Latitude, ——.
Director: J. T. WOLF.

BOTHKAMP (NEAR KIEL), PRUSSIA.

Sternwarte des Kammerherrn von Bülow.

Longitude from Greenwich, 40ᵐ 30.8ˢ E.
Latitude, 54° 12′ 9″ 6 N.
Owner: Kammerherr VON BÜLOW.
Astronomers: Dr. VOGEL, 1870.
Dr. LOHSE, 1870.
Dr. DE BALL, 1881, 1882.
F. C. LAMP, 1883.

The observatory was established in 1870. Most of the work done between the years 1870 and 1874 was spectral analysis by Drs. VOGEL and LOHSE. These gentlemen receiving a call to the Astro-physical Observatory at Potsdam, the observatory remained in idleness until 1881, when Dr. DE BALL took charge. On September 3, 1882, he discovered here a planetoid (230).

BORDEAUX, FRANCE.

Observatoire.

Longitude from Greenwich, 2ᵐ 5.54ˢ E.
Latitude, 44° 50′ 17″ N.
Authority for longitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Director: G. RAYET, 1879.

The observatory, created by a decree of the President of the French Republic under date of March 11, 1878, was erected at the joint expense of the city and the Republic on the summit of a hill, about 4 kilometers (2½ miles) E.S.E. of the center of the city. Each instrument is placed in a separate building.

BREMEN, GERMANY.

I. *Observatorium der Navigations-Schule.*

Longitude from Greenwich, $35^m 15^s$ E.
Latitude, 55° 4′ 48″ N.
Director : ——.

II. *Observatorium des Herrn Olbers.*

Longitude from Greenwich, $35^m 15^s$ E.
Latitude, 53° 4′ 36″ N.
Authority for longitude and latitude: (Astr. Nach., IV, 392) Connaissance des Temps, 1884, p. XXVI.
Director : ——.

BRESLAU, PRUSSIA.

Universitäts Sternwarte.

Longitude from Greenwich, $1^h 8^m 8.90^s$ E.
Latitude, 51° 6′ 56.5″ N.
Directors : L. A. JUNGNITZ, 1780.
E. J. SCHOLTZ, 1831.
P. H. L. von BOGUSLAWSKI, 1841.
Prof. DR. J. G. GALLE, 1851.

Established by L. A. JUNGNITZ.

Observations here were begun about 1760 at the gymnasium, (high-school) where J. E. Scheibel, the professor of mathematics, had collected a few instruments. They were continued at the university, and the observatory properly so called was gradually developed.

BREST, FRANCE.

Observatoire de la Marine.

Longitude from Greenwich, $17^m 58^s$ W.
Latitude, 48° 23′ 32″ N.
Authority for longitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887; for latitude, Connaissance des Temps, 1884, p. iv.
Director : DE KERMAREC.

BRUSSELS, BELGIUM.

I. *Observatoire Royal.*

Longitude from Greenwich, $17^m 28.9^s$ E.
Latitude, 50° 51′ 10.7″ N.
Directors : L. A. J. QUETELET, 1829.
J. C. HOUZEAU, 1876.
F. FOLIE, ——.

Projected in 1826, begun in 1829, completed in 1831. A large hall for meridian observations is located between two wings, each surmounted by a turret.

II. *Observatoire de C. Montigny* (*Private*).

Longitude from Greenwich, ——.
Latitude, ——.
Director: C. MONTIGNY.

BUDA-PESTH, HUNGARY.

I. *Sternwarte.*

Longitude from Greenwich, $1^h\ 16^m\ 13^s$ E.
Latitude, 47° 29′ 12″ N.
Authority for longitude and latitude: (LINDENAU, 1846, c. 1866), Connaissance des Temps, 1884, p. xxix.
Directors: J. PASQUICH, 1804.
P. TITTEL, 1824.
L. MAYER, 1831.

Founded upon the "Blocksberg" or "Gerhardsberg" in 1803, and was destroyed in 1849.

II. *Geodetisches Observatorium des Polytechnikums.*

Longitude from Greenwich, $1^h\ 16^m\ 15.4^s$ E.
Latitude, 47° 29′ 34.7ˢ N.
Authority for longitude and latitude, A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Director: STEPHEN KRUSPER.

III. *K. Ung. Central-Anstalt für Meteorologie und Erdmagnetismus.*

Longitude from Greenwich,
Latitude,
Director: Dr. GUIDO SCHENZL.

BUKAREST, ROUMANIA.

Universitäts Sternwarte.

Longitude from Greenwich, $1^h\ 44^m\ 26^s$ E.
Latitude, 44° 25′ 39″ N.
Director: ——.

BUSHEY HEATH, ENGLAND.

Observatory.

Longitude from Greenwich, $1^m\ 20^s$ W.
Latitude, 51° 37′ 44″ N.
Authority for longitude and latitude: Connaissance des Temps, 1884, p. xiii.
Director: ——.

CADIZ, SPAIN.

Naval Observatory. (See *San Fernando.*)

CAIRO, EGYPT.

Observatoire Khédivial.

Longitude from Greenwich, 2h 5m 8.91s E.
Latitude, 30° 4′ 38.2″ N.
Authority for longitude and latitude: Liste Générale des Observatoires et Astronomes, 1887.
Director: MAHMOUD.

Founded about 1850.

CAMBRIDGE, ENGLAND.

Cambridge Observatory.

Longitude from Greenwich, 22.75s E.
Latitude, 52° 12′ 51″.6 N.
Directors: W. LUDLAM, 1767.
A. SHEPHERD, 1769.
S. VINCE, 1797.
R. WOODHOUSE, 1820.
G. B. AIRY, 1827.
J. CHALLIS, 1836.
J. C. ADAMS, 1860.

Commenced at Christ College; removed to St. John's College in 1767. In 1764 a special location was assigned to it above the entrance gate of Trinity College. The senate of the university caused a better observatory to be erected in 1820, which was completed in 1824. The structure consists of four halls, forming a cluster of buildings.

CAPETOWN, AFRICA.

Royal Observatory, Cape of Good Hope.

Longitude from Greenwich, 1h 13m 55s E.
Latitude, 33° 56′ 3.4″ S.
Authority for longitude, HENDERSON; for latitude, E. J. STONE.
Directors:
F. FALLOWS, 1820.
T. HENDERSON, 1831.
T. MACLEAR, 1834.
E. J. STONE, 1870.
DAVID GILL, 1879.

Founded in 1820. Owned no instruments of importance until 1829. It was not at this observatory that JOHN HERSCHEL made his observations, but some distance from here on a private estate called *Feldhausen*.

INSTRUMENTS:

(*a*) *Meridian circle*, by RANSOME & SIMMS for the engineering part; TROUGHTON & SIMMS for micrometric and optical part; a sister instrument to the Greenwich circle; diameter of circles, 66 inches, divided to 5′; read by 6 microscopes to 0′.01 estimating easily to 0′.001 as at Greenwich. Aperture of objective, 8 inches; magnifying power always employed, 200 diameters.

(*c*) *Equatorial instruments:* Makers, object-glass by MERZ, mounting (German form) by TROUGHTON & SIMMS; aperture of objective, 6.9 inches; magnifying power of eye-pieces, 40 to 400. (*c*′) Small equatorial, 3.6-inch aperture (DOLLARD), 46 inches focal length, mounting on long polar axis (English form), maker unknown; without clock-work, at present dismounted.

(*d*) *Spectroscope:* Spectroscope by TROUGHTON & SIMMS.

(*f*) *Chronograph*, one by BOND, not at present in use.

(*g*) *Clocks:* One mean time; maker, MOLYNEUX: one sidereal, maker, BARRAUD.

(*h*) *Chronometers:* Mean time and sidereal. A supply of these instruments kept for use of Her Majesty's ships; consequently frequently changed.

(*i*) *Miscellaneous:* A heliometer of 5 feet focal length, 4 inches (French) aperture. Tube and cradle by REPSOLD, mounting by GRUBB. (This instrument is the private property of Mr. GILL.)

CARLSBURG, HUNGARY.

Sternwarte.

Longitude from Greenwich, $1^h\ 34^m\ 17^s$ E.
Latitude, 46° 4′ 17″ N.
Auchority for longitude and latitude: Connaissance des Temps, 1884, p. xxix.
Director: Domherr FRANZ BARES.

CATANIA, ITALY.

Observatory on Mount Etna.

Longitude from Greenwich, ———.
Latitude, ———.
Director: ———.

CHAPULTEPEC, MEXICO. (See TACUBAYA.)

Observatorio Astronómico Nacional.

Longitude from Greenwich, $6^h\ 36^m\ 38.24^s$ W.
Latitude, 19° 25′ 17.5″ N.

Projected in 1876; established in 1878; transferred to TACUBAYA on March 8, 1883.

CHRISTIANIA, NORWAY.

Universitäts-Sternwarte.

Longitude from Greenwich, 42^m 53.65^s E.
Latitude, 59° 54′ 43.7″ N.
Authority for longitude and latitude: Beschreibung und Lage der Universitäts-Sternwarte in Christiania; Verhandlungen der fünften allgemeinen Conferenz der europäischen Gradmessung, p. 300; Expéd. chronom. exécutée en 1844 entre Alton et Greenwich.
Directors: C. HANSTEEN, 1815.
C. FEARNLEY, 1873.

Projected in 1815; constructed in 1818; rebuilt at some distance from the first structure in 1830.

INSTRUMENTS:

(*a*) *Meridian circles:* One; makers, ERTEL, with objective by FRAUENHOFER and UTZSCHNEIDER: diameter, 38 inches; divided to 3′, read by 4 microscopes to 2″; aperture of objective, 4 inches; magnifying power, 180 diameters.

(*b*) *Portable transit instrument:* PISTOR & MARTINS, makers; aperture of objective, 2 inches; magnifying power, 80 diameters.

(*c*) *Equatorial* by A. & G. REPSOLD. Diameter of circles, 30 inches, divided to 3′; read by 2 microscopes to 1″; aperture of objective, 4½ inches; magnifying power, 50–290. Wire micrometer and ring micrometer. (*c′*) Refractor: Makers, G. MERZ & SÖHNE; objective, 7 inches; magnifying power, 80–600; diameters of circles 10 and 14 inches; read by 2 Noniers each to 4^s and 10″. Wire micrometer.

(*d*) Small universal star-spectroscope by MERZ, à vision directe.

(*g*) *Clocks:* One sidereal: pendulum, by KESSELS, 1365; one mean time, by URB. JURGENSEN OG SÖNNER (for the bifilar): one by L. LAMTVORK (for the unifilar); F in the magnetic building.

(*h*) *Chronometers:* Mean time; (Box) KESSELS, 1259; (Pocket) KESSELS, 1280: one sidereal; DENT, 2103.

(*i*) Unifilar magnetometer, by MEYERSTEIN; bifilar magnetometer, by MEYERSTEIN inclinatometers, by GAMBEY, BARLOW, Dover; siphon barometer, by PISTOR; cistern barometer, by FORTIN; thermometers, pluviameters, etc.

CHURTS, ENGLAND.

Private Observatory.

Longitude from Greenwich, ———.
Latitude, ———.
Director: R. CARRINGTON.

Discontinued upon the death of Mr. CARRINGTON in 1875.

COIMBRA, PORTUGAL.

Observatorio Magnetico-Meteorologico de la Universidade de Coimbra.

Longitude from Greenwich, 33m 34.1s W.
Latitude, 40° 12′ 25.8″ N.
Directors: J. MONTEIRO DE ROCHA, 1796.
DE PINHEIRO, 1820.
DE SOUZA PINTO, 1855.

Established about 1796. From 1779 to the present time the Astronomical Ephemeris has been published here, which for ten years previous (1789) had been issued at Lisbon.

COLLOONEY, IRELAND (See MARKREE).

COLOGNE, PRUSSIA (SEE KLÖN).

COLOMBO, CEYLON, ASIA.

Private Observatory.

Longitude from Greenwich, 5h 19m 23s E.
Latitude, 6° 55′ 33″ N.
Authority for longitude and latitude: Connaissance des Temps, 1884, p. xxxix.
Director: Mr. GREEN.

CONSTANTINOPLE, TURKEY.

Observatoire Impérial.

Longitude from Greenwich. 1h 55m 56s E.
Latitude, 40° 1′ 40″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Director: A. COUMBARY.

COPENHAGEN, DENMARK.

Universitets Astronomiske Observatorium.

Longitude from Greenwich, 50m 19.2s E.
Latitude, 50° 41′ 13.6″ N.
Directors: C. LUMBORG, 1637.
T. BARTHOLIN, 1647.
O. ROEMER, 1681.
PETER I. HORREBOW, 1714.
C. HORREBOW, 1753.
T. BUGGE, 1777.
H. C. SCHUMACHER, 1815.
VON CAROC, 1822.
C. F. R. OLUFSEN, 1832.
H. D'ARREST, 1856.
T. N. THIELE, 1875.

Founded in 1637, but only completed in 1656. The first edifice was destroyed by fire the 20th of October, 1728. The observatory was re-established in the round tower belonging to the University. In 1820 a wooden addition was made to it on the Holken bastion. In 1857 it was removed to the glacis of the fortress between the citadel and the Osterthor (eastern gate). In 1859–'60, a new building was erected upon the Rosenborg bastion of the old fortress. At present this new observatory is surrounded by the Botanical Garden.

CORDOBA, ARGENTINE REPUBLIC.

Observatorio Nacional Argentino.

Longitude from Greenwich, $4^h\ 16^m\ 45.1^s$ W.
Latitude, 31° 25′ 15.4″ S.

Director: B. A. GOULD, 1870.

Proposed in 1869; built in 1871 on an eminence southeast of the town; a cruciform structure, with four towers at the extremities of the limbs of the cross.

CORK, IRELAND.

Observatory of Queen's College.

Longitude from Greenwich, $33^m\ 51^s$. W.
Latitude, 51° 54′ N.
Authority for longitude and latitude: Connaissance des Temps, 1884, p. xiii.
Director: ———.

Founded in 1878. Hill for meridian observations. Dome, 14¾ feet ($4^m.5$) in diameter.

CRACOW, AUSTRIA. (See KRAKAU.)

K. K. Universitäts Sternwarte.

CRONSTADT, RUSSIA. (See KRONSHTADT.)

Naval Astronomical Observatory.

CROWBOROUGH, SUSSEX, ENGLAND.

Private Observatory.

Longitude from Greenwich: 9.30^s E.
Latitude: 51° 3′ 14″ N.
Director: CHAS. LEESON PRINCE.

Founded at Uckfield, Sussex, in 1854. Removed to the summit of Crowborough Hill in 1872.

CUCKFIELD, ENGLAND.

Observatory of G. Knott (Private).

Longitude from Greenwich, 0^{m} 34^{s} W.
Latitude, 51° 0′ 35″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Proprietor: G. KNOTT.

CZERNOWITZ, AUSTRIA.

Physikalisches Institut der k. k. Franz Josephs Universität.

Longitude from Greenwich, ———.
Latitude, ———.
Director: Prof. ALOIS HANDL.

DANZIG, PRUSSIA.

Observatorium der Naturforschenden Gesellschaft.

Longitude from Greenwich: 1^{h} 14^{m} 37^{s}.9 E.
Latitude: 54° 25′ 58″ N.
Directors: VON WOLF, 1780.
Dr. BERENDT, 1784.
Dr. JUL. AUG. KOCH, 1792–1817.
Dr. WESTPHAL, 1820–1821.
Dr. THEODOR ANGER, 1831.
——— FLEMMING, 1840.
——— KAYSER, 1860.

The observatory was planned by WOLF, and in 1780 the corner stone for the building was laid by him on the summit of the Bishofsberg, an elevated position. In 1781 the building was completed and used by WOLF; on the 17th of December, 1781, for the observation of the solar eclipse.

In 1806 the invasion of the French army necessitated the removal, to a safe location in the city, of the instruments, and the building on the Bishofsberg was occupied by the French army and partly torn down, but through the exertions of Dr. KLEEFELD, of the society, the French provincial governor, General RAPP, had it restored. In 1812, however, its complete devastation became a necessity of war.

In 1818 the society reclaimed the old site, intending to rebuild the observatory; the failure of obtaining the requisite funds, however, caused the project temporarily to be abandoned.

Meteorological observations alone were continued in Schönberg, near Carthaus. The collecting of astronomical instruments was continued, and in 1831 a small observatory was erected upon the "Apotheke," in the "Neugarten."

In 1866 the society authorized the erection of the present observatory, which was completed and inaugurated on the 2d of January, 1868, the one hundred and twenty-fifth anniversary of the Naturforschende Gesellschaft.

DERPT (DORPAT), RUSSIA.

Imperatorskaia Astronomicheskaia Observatoria.

Longitude from Greenwich, 1^h 46^m 53.5^s E.
Latitude, 58° 22′ 47.4″ N.
Directors: J. W. A. **PFAFF**, 1808.
F. G. W. **STRUVE**, 1813.
J. H. **MADLER**, 1840.
T. **CLAUSEN**, 1874.
L. **SCHWARZ**, 1878.

Founded in 1808 as a dependency of the university. In 1825 **FRAUNHOFER'S** equatorial, with an aperture of 9 inches and a focal length of 13½ feet, moved by clock-work, the largest and most powerful refractor in the world at that time, was mounted there. With the help of this instrument the elder **STRUVE** accomplished his famous *Mensuræ Micrometricæ*, published in 1837, and continued by his successor.

DENTZ, GERMANY.

Sternwarte des Herrn E. Mengering (*Private*).

Longitude from Greenwich, 27^m $49^s.9$ E.
Latitude, 50° 56′ 33″ N.
Authority for longitude and latitude: A. **LANCASTER**, Liste Générale des Observatoires et Astronomes, 1887.
Proprietor: E. **MENGERING**.

DRESDEN, SAXONY.

I. *Königliches Mathematisch-Physikalisches Institut.*

Longitude from Greenwich, 54^m 56^s E.
Latitude, 51° 3′ 45″ N.
Authority for longitude and latitude: A. **LANCASTER**, Liste Générale des Observatoires et Astronomes, 1887.

Directors: J. Otto, 1560–1580.
M. Jostelin, 1580–1609.
L. Brunner, 1609–1637.
Th. Häsell, 1637–1661.
Tob. Beutel, 1661–1720.
B. Michaelis, 1720–1740.
H. Eulenburg, 1740–1743.
F. Walz, 1743–1747.
J. Mayen, 1747–1768.
E. Zeiter, 1768–1783.
G. Köhler, 1783–1801.
S. Seiffert, 1801–1818.
A. Schmidt, 1818–1828.
G. Lohrmann, 1828–1840.
R. Blochmann, 1840–1869.
A. Drechsler, 1869.

The Royal Mathematical-Physical Institute, an astronomical and meteorological observatory, together with a considerable collection of astronomical, physical, and mathematical instruments, dating principally from the XVI, XVII, and XVIII centuries, had its origin in the cabinet of art which was founded in 1560 by August I, Elector of Saxony.

II. *Private Observatorium des Herrn B. von Engelhardt.*

Longitude from Greenwich, $54^{m}\ 54.80^{s}$ E.
Latitude, 51° 2′ 16.80″ N.
Director: B. von Engelhardt.

III. *Private Observatorium des Herrn Dr. Hugo Guericke.*

Longitude from Greenwich, ———.
Latitude, ———.
Director: Dr. Hugo Guericke.

DRONTHEIM, NORWAY.

Observatory.

Longitude from Greenwich, $41^{m}\ 49^{s}$ E.
Latitude, 63° 25′ 48″ N.
Authority for longitude and latitude: Connaissance des Temps, 1884, p. xx.

DUBLIN, IRELAND.

Dunsink Observatory.

Longitude from Greenwich, $25^{m}\ 21^{s}$ W.
Latitude, 53° 23′ 13″ N.
Authority for longitude and latitude: Dr. Brünnow.

Directors: H. USSHER, 1774.
J. BRINKLEY, 1792.
W. R. HAMILTON, 1827.
F. BRÜNNOW, 1865.
ROBERT S. BALL, Astronomer Royal of Ireland, 1875.

Dunsink Observatory belongs to Trinity College, Dublin. It was founded in 1774, by means of a legacy left for the purpose by F. ANDREWS. It is built in the midst of a vast park at Dunsink, 3¾ miles (6 kilometers) northwest of Dublin, and was not finished until 1792. It is a structure of three stories, surmounted by a revolving dome. An annual visitation of the Observatory is held every summer by the board of Trinity College.

INSTRUMENTS:

(*a*) *Meridian circle:* Makers, PISTOR & MARTINS; diameter of circles, 36 inches; divided to 2′; read by 8 microscopes to 1″; aperture of objective, 6.4 inches; magnifying power ordinarily employed, 180 diameters.

(*b*) *Meridian transit instruments:* One, made by RAMSDEN; aperture, 4 inches; not in use. (*b′*) One with reversible circle by RAMSDEN & BERGE; object-glass, 3 inches; diameter of circle, 8 feet; 3 micrometers; not in use.

(*c*) *Equatorial instruments:* One; makers, CAUCHOIX object-glass, GRUBB mounting; aperture of objective, 11¾ inches; magnifying powers of eye-pieces, 300; is generally used. (*c′*) One of 4 inches aperture; English equatorial by TULLEY. (?) Hardly ever used.

(*d*) *Spectroscopes:* One of BROWNING'S 2-prism spectroscopes; and one of VOGEL'S small-star spectroscopes.

(*f*) *Chronograph:* Maker, GRUBB; two barrels and controlled clock.

(*g*) *Clocks:* One mean time; maker, BOOTH, of Dublin; one sidereal; maker, DENT, London.

(*h*) *Chronometer:* Sidereal; maker, M'MASTER.

(*i*) *Miscellaneous:* The mean-time clock controls by electricity the clocks in the port and docks board and Trinity College, the distance being about 5 miles from Dunsink.

DUN ECHT (ABERDEEN), SCOTLAND.

Longitude from Greenwich, $9^{m}\ 40^{s}$ W.
Latitude, 57° 9′ 36″ N.
Authority for longitude: Ordnance Survey; for latitude, observations with a SIMMS'S alt-azimuth. The transit circle confirms the result within a fraction of a second.
Astronomer: RALPH COPELAND.

Dun Echt Observatory, the property of the EARL OF CRAWFORD AND BALCARRES (late Lord Lindsay), is on the estate of Dun Echt, about 13 miles west of Aberdeen.

INSTRUMENTS:

(*a*) *Meridian circles:* 1. Transit circle by TROUGHTON & SIMMS; one movable and one fixed circle; diameter 36 inches, divided to 5″; 16 microscopes (carried by 2 Alidade circles, 1 movable and 1 fixed), reading to 1″-tenth by estimation; aperture of object-glass 8.59 inches; 6⅙-inch collimators; 2½-inch axle telescope. 2. Reversing transit with V's for meridian and prime vertical, by T. COOKE & SONS; 4-inch object-glass. 3. Transit instrument by TROUGHTON & SIMMS; 2¾-inch object-glass.

(*b*) *Meridian transit instruments:* 1. Alt-azimuth, by TROUGHTON & SIMMS; 12-inch circles, divided to 5′; 4 microscopes, vertical and horizontal circles reading seconds and tenths by estimation. Horizontal circle movable. 2. Theodolite by T. COOKE & SONS. 3. Theodolite by APPS.

(*c*) *Equatorial instruments:* One 15.06-inch refractor by GRUBB. Several sets of eye-pieces. Bifilar micrometer. MERZ helioscope. DAWES solar eye-piece, 2, 3, 74-inch finders. This telescope is controlled absolutely by the sidereal clock. Driving-clock by T. COOKE & SONS, made to special design. 2. One 12.9-inch reflector 122.5 focus; mirror by Rev. H. COOPER KEY, English mounting. 3. One 12¼-inch reflector by BROWNING. Solar spectroscope. 4. One 6.06-inch refractor by SIMMS; bifilar and double image micrometers, used generally for comet seeking. 5. One 6.04-inch refractor by T. COOKE & SONS; complete. 6. One 4-inch refractor by T. COOKE & SONS; bifilar micrometer. Clock by EICHENS; complete. 7. One 3-inch refractor by T. COOKE & SONS. Bifilar micrometer; complete.

(*d*) *Spectroscopes:* Large solar spectroscope with 1 whole and 2 half RUTHERFURD prisms, with reversion and heliometer viewing telescope. Stellar spectroscope modified at Dun Echt (the one most used). BROWNING 5-prism automatic solar spectroscope and 2 stellar ones; also VOGEL spectroscope by HEUSTRELL, and a variety of direct vision, quartz, and other prisms. Besides the above-mentioned spectroscope there is a 6-prism automatic reversing-table instrument by BROWNING, and a hand direct-vision spectroscope used for auroræ.

(*e*) *Photometer:* ZÖLLNER astro-photometer by AUSFELD of Gotha.

(*f*) *Chronographs:* 1. Four-fold barrel-chronograph, each barrel to run six hours, driven by the same clock as the 15.06-inch equatorial. 2. Portable fillet chronograph by SIEMENS.

(*g*) *Clocks:* 1. Sidereal clock, quicksilver compensation by FRODSHAM. 2. Mean-time clock, quicksilver compensation by MOLYNEUX. 3. Electric clock, outside dial and time gun.

(*h*) *Chronometers:* 1. KULLBERG; mean time. 2. FARQUHAR; mean time. 3. J. WALKER; mean time. 4. FRODSHAM; mean time 8-day. 5. WALKER; sidereal (electric contact). 6. WALKER; sidereal. 7. MCLENNAN; $\frac{4}{10}$ seconds; pocket M. T.

(*i*) *Miscellaneous:* 1. Metre: A copy of the Mètre du Conservatoire.

Froment. 2. Linear dividing engine by Froment. 3. Linear dividing engine by Elliott Brothers. 4. Photograph measuring machine by Grubb. 5. Balance by Oertling. 6. Five 2-meter and one 1¼-meter bars; Grubb. 7. Two comparator microscopes and long stone table. 8. Ten-inch wheel cutting engine, Swiss; Jenssen & Hensen.

(*j*) 1. Sprengel pump six end on and many Geissler tubes. 2. Air-pump and apparatus.

(*k*) Various photographic apparatus.

(*l*) A large assortment of electrical and electro-magnetical apparatus. One standard and one marine barometer, Negretti & Zumbra. Various thermometers. Seven-inch spherometer, 1 part=$\frac{1}{10000}$ inch, $\frac{1}{100000}$th by estimation; 4-inch spherometer; both by Hilger. Arithmometer by Thomas de Colmar; six places. Arithmometer by Thomas de Colmar; ten places. Foucault siderostat by Eichens; 16-inch mirror (and a spare one), silver in glass, by A. Martin. Silbermann heliostat by Duboscq. Heliostat by Browning. King's barograph and anemograph by Casella. Binocular microscopes by Smith & Beck and Ross. Polariscope by Ladd; 10-inch, 6-inch, and 4-inch induction coils by Apps. A large collection of cut crystals; also diffraction apparatus by Schwerd.

DURBAN (NATAL), AFRICA.

Observatory.

Longitude from Greenwich, $2^h\ 2^m\ 1.18^s$ E.
Latitude, 29° 50′ 47.4″ S.
Authority for longitude and latitude: A. Lancaster, Liste Générale des Observatoires et Astronomes, 1887.
Director: E. Neisson, Government Astronomer.

DURHAM, ENGLAND.

University Observatory.

Longitude from Greenwich, $6^m\ 19^s.75$ W.
Latitude, 54° 46′ 6.2″ N.
Directors: Temple Chevallier, 1840.
Samuel Waymouth, 1872.
Robert John Pearce, 1873.

Founded by subscription, 1840. First observations made in 1842. The observatory is under the general superintendence of the professor of mathematics in the University of Durham.

DÜSSELDORF, PRUSSIA.

Sternwarte (formerly at Bilk near Düsseldorf).

Longitude from Greenwich, $27^m\ 5^s$ E.
Latitude, 51° 12′ 25″ N.
Authority for longitude and latitude, "Astronomische Nachrichten," 643, und "Berliner Jahrbuch."

Directors: J. F. BENZENBERG, 1809–1846.
F. BRÜNNOW, 1847–1851.
ROBERT LUTHER, 1851.

Established in 1809, by J. F. BENZENBERG, the savant, who in 1844 erected a more complete building at BILK, 1¼ miles (2 kilometers) south of the town. This establishment, liberally endowed by its founder, became the property of the town in 1847, and was enlarged by it in 1852.

INSTRUMENTS:

(*a*) An old repetition circle of 1 foot, by the late BAUMANN, at Stuttgart, giving 10″ of centesimal division.

(*b*) Meridian transit instrument made by the late EMIL SCHROEDTER, at Düsseldorf, objective from Munich, focal distance 2 feet, aperture 2 inches, little circle divided in half degrees, with nonius, 1 minute.

(*c*) New equatorial instrument, by CHARLES BAMBERG, at Berlin, in use since September, 1877, objective by Dr. SIGMUND MERZ, at Munich, focal distance 7 feet, aperture 7 inches, magnifying powers of eye-pieces 49 to 188. Stars of the 11.5 magnitude can be seen with it. Old reserve tube, with horizontal and vertical motion, made by MERZ & SONS, at Munich, 1847, focal distance 6 feet, aperture 4⅓ inches. Stars of the 11.0 magnitude can be seen with it.

(*n*) Two old sidereal-time clocks made by UTZSCHNEIDER & FRAUENHOFER, at Munich.

(*h*) One mean-time chronometer by KESSELS, at Altona, and a Swiss watch.

Some small instruments of minor importance.

EDINBURGH, SCOTLAND.

I. *Royal Observatory.*

Longitude from Greenwich, 12^m 43.05^s W.
Latitude, 55° 57′ 23.2″ N.
Authority for longitude: C. PIAZZI SMYTH; for latitude, THOMAS HENDERSON.
Directors: THOMAS HENDERSON, 1833–1844.
C. PIAZZI SMYTH, 1845.

A preceding so-called observatory tower existed on the site, which is a grassy and rocky hill-top in the midst of the city, from 1776, but no observations of scientific character were ever made there. It was founded by subscription, and was not completed until 1792. The present observatory was projected in 1812 and erected on shares in 1812. The municipality donated the ground. In 1833 the founders ceded its administration to the state, and in 1846 made over the ownership.

It is by no means a model building for an observatory, being small, isolated, smoke-exposed, without dwelling-houses attached, often difficult of access at night, hide-bound by its too ornamental white-stone Greek architecture; and looking, as well as acting, rather like a classical temple of the winds than a modern working observatory.

II. *Ben Nevis Observatory.*

Longitude from Greenwich, ———.
Latitude, ———.
Director: ———.

ELSFLETH (OLDENBURG), GERMANY.

Sternwarte der Navigations Schule.

Longitude from Greenwich, $33^m\ 52^s$ E.
Latitude, 53° 14′ 46″ N.
Authority for longitude and latitude: Connaissance des Temps, 1884.
Director: C. BEHRMANN, 1876.

ERLAU, HUNGARY.

Sternwarte.

Longitude from Greenwich, $1^h\ 30^m\ 32^s$ E.
Latitude, 47° 54′ 4″ N.
Authority for longitude and latitude: Connaissance des Temps, 1884.
Director: DR. ALBERT FRANZ VON MONTEDEGO.

EKATHERINEBOURG, RUSSIA.

Magnetic and Meteorological Observatory.

Longitude from Greenwich, $4^h\ 2^m\ 48^s$ E.
Latitude, 56° 49′ N.
Authority for longitude and latitude: KUPFFER, 1841; FRITSCHE, 1873 and 1876; SCHARNHORST und KUHLBERG, 1875.
Director: G. O. CLERK.

The observatory was built in 1835; regular observations began on January 1, 1836. It took part in the work of the first "Magnetischer Verein," and has lately been required to act as a "polar observatory," from August 1, 1882, until September 1, 1883, according to the programme of the International Polar Commission, St. Petersburg, August, 1881.

INSTRUMENTS:

(b) *Meridian transit instrument:* Makers, ERTEL & SOHN (small passage instrument), aperture, 1.5 inches. (b′) Another by BRAUER in St. Petersburg (universal instrument).

(g) *Clocks:* One mean time; maker, F. FLAUTH, in St. Petersburg (without No.); another regulator, without name.

(h) *Chronometers:* Mean time; makers, F. FLAUTH, No. 37; WIREN, No. 86.

(i) *Miscellaneous:* Magnetic theodolite, BRAUER, No. 37; BRAUER'S compass for magnetical declination and intensity; GAMBEY'S inclinatorium; variation magnetometers (syst. GAUSS); several series of meteorological instruments of different construction; thermometers for observation of the temperature from superficy to 3 meters depth.

FLORENCE, ITALY.

I. *Reale Osservatorio Astronomico di Firenze ad Arcetri.*

Longitude from Greenwich, 45^{m} 3.13^{s} E.
Latitude, 43° 45′ 14.3″ N.
Authority for longitude and latitude: Royal Staff of Engineers.
Director: GUGLIELMO TEMPEL.

II. *Observatory of the Royal Museum.*

Longitude from Greenwich, 45^{m} 1.5^{s} E.
Latitude, 43° 46′ 4.1″ N.
Directors: PROF. F. FONTANA, 1784.
ALESSANDRO GALILEI.
—— FABBRONI, 1805.
COUNT GIROLAMO BARDI, 1807.
DOMENICO DE VECCHI, 1808.
GAETAMO DEL RICCO, 1814.
FATHER INGHIRAMI, 1815.
LUIGI PONS, 1825.
GIOVANNI BATTISTA AMICI, 1837.
G. B. DONATI, 1859.
DOMENICO CIPOLETTI, 1873.
PROF. PITTEI, 1874.
GUGLIELMO TEMPEL, 1875.

III. *Meteorological Observatory of the Royal Museum.*

Longitude from Greenwich, ———.
Latitude, ———.
Director: Dr. PITTEI, 1875.

IV. *Observatory of San Giovannino* (*Ximeniano*).

Longitude from Greenwich, ———.
Latitude, ———.
Director : Prof. F. CECCHI.

Founded by FATHER LEONARDO XIMENES, a Jesuit.

In the annals of the Imperial Museum of Florence, Vol. II, for the year 1810, we read that about the year 1784, the Grand Duke LEOPOLD I gave directions to his architect, GASPERO PAOLETTI, to make the designs for an observatory to be erected within the precincts of the Imperial and Royal Museum of Physical Science and Natural History of Florence, of which the ABBÉ FÉLIX FONTANA was director.

Prof. DOMENICO DE VECCHI, in an astronomical report inserted in the above-mentioned annals, declares that after diligent search he was unable to discover any historical document relative to the erection of this observatory, and that the date of 1774 was given him by the Engineer DEL ROSSO. The same professor De Vecchi, in the introduction to the description of the Imperial Observatory (above annals, Vol. II), declares it to have been already constructed and furnished with some instruments as far back as the year 1775.

In the year 1784, there had been collected in the observatory a clock, a transit instrument, and zenith sector, for the work of Professor SLOP, of the University of Pisa, who also constructed a meridian, passing under the pavement of a hall, which owes its name to this circumstance and bears the following inscription: "Linea meridiana ducta in observatrio Regii Musæi Scientiorum Florentini, Petro Leopoldo, Imperante anno, MDCCLXXXIV."

In the year 1784, Professor FONTANA began the meteorological observations, using eight large instruments of his own invention and constructed under his attention, care, and direction. Arrested in his career by calumny, and in consequence withdrawn from the Museum. Fontana was succeeded as director *pro tempore* by ALESSANDRO GALILEI; he was succeeded by FABBRONI, nominated by the ecclesiastical party in 1789 vice-director under Fontana.

On the 1st of January, 1805, we find the entry of the death of this distinguished scientist, at a distance from that Museum, to which he had rendered such service as instructor and director.

Shortly after, FABBRONI having been appointed director of the mint, Count GIROLAMO BARDI was named director of the museum in his place. He immediately founded several chairs of instruction, among them one of astronomy, which was assigned to DOMENICO DE VECCHI, professor of physical sciences at the University at Sienna, and to him was also entrusted the directorship of the observatory (1807).

DE VECCHI remained in this position in the Florentine Observatory until July, 1814, when he was removed by an order of the Commissario Plenipotenziario, Prince RASPIGLIOLI, under date of June 22, 1814. (This order is found in a letter addressed to the director of the museum, number 92, in the file of papers relating to the transactions of the I. and R. Museum for the year 1814.) Professor DE VECCHI himself refers to this suppression in the memorial before mentioned, in speaking of the methods of observing with reflecting instruments. Professor DE VECCHI never returned to his office as instructor in the observatory.

In the letter of Prince RASPIGLIOLI to the director of the museum it was also stated: "I think it well to inform you that Father GAETANO DEL RICCO has been invited to take charge of the preservation of the astronomical instruments," which, in consequence, were received from the professor himself, and held from June, 1814, to May 17, 1818, on which day, having passed from this life, Father GAETANO DEL RICCO was succeeded by Father INGHIRAMI, professor of astronomy in the Ximeniano Observatory.

At this point it is necessary to observe that the observatory of the Royal Museum was always an entirely distinct institution from that of San Giovannino, some time designated degli Scolopi, the latter having been founded by Father LEONARDO XIMENES, Jesuit, from whom it derived the name of Ximeniano, which it retains and by which it is at this time especially distinguished.

Father INGHIRAMI held the position until the 7th of October of the same year, when, by desire of the Count, he had added to his other duties those of Director of the Museum.

From 1814 to 1825 we find no document which proves the presence of an astronomer; it remained wholly inactive for a period of about eleven years.

In July, 1825, Prof. LUIGI PONS, of Marseille, was appointed, and succeeded in 1837 by Prof. GIOVANI BATTESTA AMICI, of Modena, who held the directorship of the observatory until 1859, when he was retired on account of extreme old age. Although all the duties of the office since 1852 had been performed by Prof. G. B. DONATI, he did not succeed to the official title of director until 1864, a year after the death of Professor AMICI.

At that time DONATI conceived the idea of erecting a new observatory in the vicinity of Florence; the old institution, in a central part of the town, no longer meeting the requirements of astronomical study, and not being large enough to hold the large and excellent equatorial constructed by his predecessor. Aided in this bold enterprise by the influence and support of the municipal, provincial, and state authority, and by securing the interest of King VICTOR EMANUEL, Professor DONATI, in October, 1872, was able to inaugurate the new observatory on the Calle d'Arcetri, a little removed from the house, where, two hundred and thirty years before, GALILEO had ended the labors of his life.

To the new institution was transferred all the scientific material belonging to the Department of Astronomy, and the place occupied by it in the observatory was devoted exclusively to meteorological observations, both branches remaining under the direction of Professor DONATI, the meteorological division being represented in Florence by his assistant, Prof. COSTANTINUS PITTEI.

DONATI having died on February 20, 1872, the charge of the new observatory was given to Prof. DOMENICO CIPOLETTI, formerly DONATI'S assistant in the astronomical course, who held it until the following May, when he began to fail. The observatory at Arcetri was provisionally confided to Professor PITTEI, until June 1, 1875, when Signor GUGLIELMO TEMPEL was called as astronomer, which position he still retains, and Professor PITTEI thereupon assumed the definite direction of the observatory of the Museum, re-organized under special direction, and entirely separated from the observatory at Arcetri.

FRANKFURT, A. M., PRUSSIA.

Private Observatory.

Longitude from Greenwich, 34^m 47.1^s E.
Latitude, 50° 7′ 3″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Director: Dr. EPSTEIN.

FUNCHAL, MADEIRA.

Observatory.

Longitude from Greenwich, 1^h 7^m 35.5^s W.
Latitude, 32° 37′ 46″ N.
Authority for longitude and latitude: Connaissance des Temps, 1884, p. lv.
Director:

GALATZ, ROUMANIA.

Private Observatory.

Longitude from Greenwich, 1^h 52^m 14^s E.
Latitude, 45° 26′ 12″ N.
Authority for longitude and latitude: Connaissance des Temps, 1884, p. xxix.
Director:

GENEVA, SWITZERLAND.

Observatoire de Genève.

Longitude from Greenwich, 24^m 36.77^s E.
Latitude, 46° 11′ 58.8″ N.

Directors: J. A. MELLET FAVRE, 1772.
M. A. PICTET TURRETIN 1790.
J. F. T. MAURICE, 1794.
P. PICTET, 1802.
A. GAUTIER, 1819.
L. F. WARTMANN, 1832.
E. PLANTAMOUR, 1840.
E. GAUTIER.

Founded in 1771, completed in 1773. Octagonal structure built in great part at the expense of J. A. MELLET, upon a casemate of the Bastion Saint Antrine. In 1829 the representative council of the canton passed a resolution for the construction of a new observatory to be built upon the same bastion, not far from the old edifice. It is composed of a main building of one story, and of two lateral turrets with hemispherical domes. In 1879 the original building had an annex built to it; at the same time a tower was erected to the west of the old building, in which the 10-inch refractor, presented to the cantons of Geneva by E. PLANTAMOUR, has been placed.

GENOA, ITALY.

I. *Observatorio delle R. Università.*

Longitude from Greenwich,
Latitude, 44° 24′ 59″ N.
Directors: GIUSEPPE GARIBALDI, 1830.
MICHELE ALBERTO BANCALARI, 1849.
PIETRO MARIA GARIBALDI, 1865.

This observatory was entirely refitted in 1874, and is particularly intended for meteorological observations.

II. *Observatory of the Hydrographic Office.*

Longitude from Greenwich, 35^m 41.4^s E.
Latitude, 44° 25′ 9.3″ N.
Director: G. B. MAGNAGHI.

GEORGETOWN, BRITISH GUIANA.

Observatory.

Longitude from Greenwich, ——.
Latitude, ——.
Director: ——.

GLASGOW, SCOTLAND.

Observatory.

Longitude from Greenwich, 17^m 10.6^s W.
Latitude, 55° 52′ 42.8″ N.
Directors: J. P. NICHOL, 1840.
R. GRANT, 1860.

Commenced in 1818 at the expense of a society. Permanently organized with the help of a public subscription, of one subsidy from the University and another from the State. In 1862 a special hall was added for an equatorial, which has an aperture of 9 inches: (0.23^{m}).

GOHLIS (NEAR LEIPZIG), SAXONY.

I. *Private Sternwarte.*

Longitude from Greenwich, 49^{m} 28.6^{s} E.
Latitude, 51° 21′ 42.3″ N.
Authority for longitude and latitude: Prof. C. C. BRUHNS.
Proprietor: AUGUST AUERBACH.

Observatory was built in 1861–'62.

II. *Private Sternwarte.*

Longitude from Greenwich, 49^{m} 29.65^{s} E.
Latitude, 51° 21′ 35″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Proprietor: W. WINKLER.

GOTHA, GERMANY.

Sternwarte.

Longitude from Greenwich, 42^{m} 50.56^{s} E.
Latitude, 50° 56′ 37.5″ N.
Directors: E. X. VON ZACH, 1787.
B. A. VON LINDENAU, 1808.
J. F. ENCKE, 1817.
P. A. HANSEN, 1825.
A. KRÜGER, 1876.
L. DE BALL (ad interim).
H. SEELIGER, 1881.
Dr. E. BECKER.

The first observatory was erected in 1784, on the "SEEBERG," 1¼ miles (two kilometers) from the town. In 1853 a new observatory was built in the "Jägerstrasse," not far from the ducal palace.

GÖTTINGEN, PRUSSIA.

Königliche Sternwarte.

Longitude from Greenwich, 39^{m} 46.4^{s} E.
Latitude, 51° 31′ 7.9″ N.
Authority for longitude and latitude: Berliner Jahrbuch.

Directors: **J. A. von Segner**, 1735.
J. Tobias Mayer, 1754.
G. M. Lornitz, 1762.
A. G. Kästner, 1764.
K. F. von Seyffer, 1800.
C. F. Gauss, 1807.
Dr. E. F. W. Klinkerfues, 1866.
Dr. W. Schur.

Founded in 1734, at the same time with the university, and located in one of the round towers of the ancient fortification, around which was built an exterior gallery. In 1811 the observatory was transferred to a more suitable spot outside the southern gate-way of the town. This new building is on the plan of a rectangle, with the longer sides facing east and west. An addition is made by wings to the north; a cupola surmounts the central vestibule, and a terrace encircles the whole structure. In 1818 the first meridian circle ever made and mounted in Europe was placed there.

Instruments:

(*a*) *Meridian circles:* One made by **Repsold**, sr., of Hamburg; diameter of circle 3½ feet, divided to 5′; read by two microscopes to 1″; aperture of objective 4½ inches (114^{mm}); magnifying power ordinarily employed, 96 diameters: one made by **Reichenbach**, of Munich; diameter of circle 3 feet; divided to 3′; read by four microscopes to 0.24″; aperture of objective 4¼ inches (109^{mm}); magnifying power ordinarily employed, 50 diameters.

(*b*) *Meridian transit instrument:* Maker, **Reichenbach**, of Munich; aperture, 4½ inches (116^{mm}); magnifying power, 75 diameters; (*b′*) one portable, maker, **Ertel**, of Munich.

(*c*) *Equatorial instrument:* Maker, **Frauenhofer**, of Munich; aperture of objective, 2.9 inches (74^{mm}); magnifying power of eye-piece, 75. (*c′*) Five telescopes: makers, 1st, **Merz**, of Munich; 6 feet long, aperture 5 inches; 2d, **Steinheil**, of Munich; 5 feet long, aperture 4 inches; 3d, **Dollond**, of Munich; 4 feet long, aperture, 3½ inches; 4th, **Dollond**, of Munich; 3 feet long, aperture 3 inches; 5th, **Plössl**, of Vienna; 28 inches long, aperture 2¼ inches. Three comet-seekers: makers, 1st, **Merz**, of Munich; 6 inches aperture; 2d, **Merz**, of Munich; 3 inches aperture; 3d, **Voigtlander**, of Brunswick; 2½ inches aperture.

(*d*) *Spectroscope:* By **Merz**, of Munich.

(*f*) *Chronograph:* By **Ausfeld**, of Gotha.

(*g*) *Clocks:* One mean time; maker, **Castens**; two sidereal: makers, 1st, **Hardy**, of London; 2d, **Shelton**.

(*h*) *Chronometers:* Four mean time; makers, 1st, **Berthoud**; 2d, **Sackmann**; 3d and 4th, **Knoblich**; 5th, **Hardy**; sixtieth part of a second.

(*i*) *Miscellaneous:* Heliometer by **Frauenhofer**, of Munich; theodolites, one by **Reichenbach**, two by **Meyerstein**; sextants by **Cary**, **Troughton**, **Pistor**, **Steinheil**, and **Breithaupt**; two heliotropes by **Meyerstein**.

GRAZ, AUSTRIA.

I. *Physikalisches Institut der K. K. Carl Franzens Universität.*

Longitude from Greenwich, ——.
Latitude, ——.
Director: Prof. Dr. **Ludwig Boltzmann**.

II. *Universitäts Sternwarte.*

Longitude from Greenwich, 1h 1m 47.9s E.
Latitude, 47° 4′ 37.2″ N.
Authority for longitude and latitude: A. **Lancaster**, Liste Générale des Observatoires et Astronomes, 1887.
Director: Dr. C. **Friesach**.

III. *Private Sternwarte.*

Longitude from Greenwich, ——.
Latitude, ——.
Director: E. **Mathey Guenet**.

GREENWICH, ENGLAND.

Royal Observatory.

Longitude from Washington, 5h 8m 12.09s E.
Latitude, 51° 28′ 38.4″ N.
Authority for longitude and latitude: Nautical Almanac, Greenwich Observations, 1878.
Directors: J. **Flamsteed**, 1675.
E. **Halley**, 1720.
J. **Bradley**, 1742.
N. **Bliss**, 1762.
N. **Maskelyne**, 1765.
J. **Pond**, 1811.
G. B. **Airy** (Astronomer Royal), 1835.
W. H. M. **Christie** (Astronomer Royal), 1881.

Founded by royal statute on the 4th March, 1675. Built in the park at Greenwich by **Christopher Wren**, architect. At first it consisted merely of an octagonal tower. In 1660 **Flamsteed** put up an additional wing to accommodate the mural sector, with the help of which he made his catalogue of stars. The board of visitors was created in 1710. In 1749 and the years immediately following great improvements and additions were made.

A statute of 1765 confirmed the right of supervision vested in the royal society and exercised by the board of visitors. In 1770 two revolving domes were constructed upon the turrets, and these have served as models for all revolving turrets since constructed. In 1772 the first achromatic object glass ever used at Greenwich was attached to the south quadrant. In 1779 the expediency of enlarging the meridian openings was acknowledged; hitherto the aperture had only been 6 inches (0.15^{m}).

At the beginning of the present century it became necessary to rebuild the observatory, and the work, continuing until 1811, consisted in the construction of two rectangular buildings, the eastern one being the observatory proper, and containing halls for the meridian instruments, the library, and office, while the western structure was intended for the dwelling house of the superintendent.

The present organization of Greenwich Observatory dates from a royal statute of 1830. According to the terms of this statute the board of visitors consists of the members of the Royal Society, the members of the Astronomical Society, and the Oxford and Cambridge professors of astronomy.

As a finishing touch the immense dome to the southeast was built in 1859.

INSTRUMENTS:

(*a*) *Meridian circle:* One; makers, RANSOMES & MAY (engineers), TROUGHTON & SIMMS (opticians); diameter of circle, 72 inches; divided to 5′; read by six microscopes to 0.06″; four supplementary microscopes for determination of division errors and occasional use: aperture of objective 8.1 inches; for observations of the sun, aperture employed, 8.1; magnifying power ordinarily employed, 195 diameters.

(*b′*) *Alt-azimuth:* Makers, RANSOMES & MAY and W. SIMMS; aperture, 4 inches. Magnifying power, 100; diameter of circles, 3 feet, divided to 5′.

(*c*) *Equatorial instruments:* Makers, RANSOMES & SIMMS (engineers), TROUGHTON & SIMMS (opticians), MERZ (objective); aperture of objective, 12.8 inches; magnifying power of eye-pieces, 60 to 1500. (*c′*) *Sheapshank's equatorial:* makers, T. GRUBB, CAUCHOIX (objective); aperture of objective, 6¾ inches. *Naylor equatorial:* maker, T. COOKE, of York; aperture, 6 inches. *Shuckburgh equatorial:* maker, RAMSDEN; aperture, 4.1 inches.

(*d*) *Spectroscopes:* Half-prism spectroscope; maker, HILGER. Direct vision: one, two, or three compound "half-prisms" with dispersions (A to H) of about 18½°, 83°, and 335°. *Single prism stereoscope:* Makers, TROUGHTON & SIMMS; one flint prism.

(*e*) *Photometer:* AIRY's double-image micrometer; makers, TROUGHTON & SIMMS.

(*f*) *Chronograph:* Makers, E. DENT & CO.

(*g*) *Clocks:* One mean time; Makers, SHEPHERD & SON: one sidereal; makers, E. DENT & CO., HARDY, ARNOLD, GRAHAM.

(*h*) *Chronometers:* Mean time; makers, various. There are always on hand a large number rated for the navy; some of these are used when necessary for the Observatory. Sidereal; none of accurate character.

(*i*) *Miscellaneous:* Photoheliograph; maker, DALLMEYER; aperture of objective, 4 inches. Several portable telescopes; aperture, 4 inches to 2¾ inches. Five other 6-inch equatorials (packed in cases) returned from Transit of Venus Expedition, 1874. Five 3-inch portable transits by SIMMS; one 14-inch alt-azimuth by SIMMS; three 14-inch altitude instruments by SIMMS; four photoheliographs by DALLMEYER (all returned from the Transit of Venus Expeditions, 1874).

GRIGNON (CÔTE D'OR), FRANCE.

Observatoire du prieuré de St. Jean.

Longitude from Greenwich, $17^m\ 38^s$ E.
Latitude, 47° 33′ 42″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Director: F. MAYEUL LAMEY.

GUILDOWN (SURREY) ENGLAND.

Private Observatory.

Longitude from Greenwich, $1^m\ 55.1^s$ W.
Latitude, 51° 13′ 39.2″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Proprietor: J. RAND CAPRON.

HABANA, CUBA.

Observatorio del R. Colegio de Belen.

Longitude from Greenwich, $5^h\ 29^m\ 30^s$ W.
Latitude, 23° 9′ 24″ N.
Authority for longitude and latitude: Connaissance des Temps, 1884, p. lxiii.
Director: ———.

HALIFAX, ENGLAND.

Bermerside Observatory, Skircoat.

Longitude from Greenwich, $7^m\ 28^s$ W.
Latitude, 53° 42′ 9″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Director: E. CROSSLEY.
Observer: J. GLEDHILL.

HAMBURG, GERMANY.

Sternwarte.

Longitude from Greenwich, 39^m 53.8^s E.
Latitude, 53° 33′ 7″ N.
Directors: —— MOSER, 1823.
K. L. C. RÜMKER, 1830.
GEORG F. W. RÜMKER, 1863.

Built by J. G. REPSOLD, in 1810, upon a location near the Altona gate; destroyed by the French in 1813; rebuilt in 1825, through a legacy left by GRELL, upon the site of the old ramparts, and still in the neighborhood of the Altona gate. It has a central hall for meridian instruments and two wings surmounted by turrets. The east wing is used for a school of navigation.

HARROW, ENGLAND.

Private Observatory.

Longitude from Greenwich, 1^m 20^s W.
Latitude, 51° 35′ 15″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Proprietor: LIEUT. COL. G. L. TUPMAN.

HEIDELBERG, GERMANY.

Sternwarte des Herrn Dr. T. Wolf.

Longitude from Greenwich, ———.
Latitude, ———.
Authority for longitude and latitude A.: LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Director: Dr. T. Wolf.

HELSINGFORS, FINLAND.

Astronomiska Observatoriet.

Longitude from Greenwich, 1^h 39^m 49.14^s E.
Latitude, 60° 9′ 2.6″ N.
Directors: F. W. A. ARGELANDER, 1829.
G. LUNDAHL, 1841.
F. WOLDSTEDT, 1852.
A. KRÜGER, 1852.
Dr. A. S. DONNER.

Founded in 1829, near the university, after the fire at Åbo had destroyed the scientific instruments of that Finnish town. This observatory is the most northerly in the world.

HERÉNY, HUNGARY.

Astro-Physikalisches Observatorium.

Longitude from Greenwich, 1^h 6^m 24.7^s E.
Latitude, 47° 15′ 47″ N.

Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.

Proprietor: E. DE GOTHARD.

Established in 1881.

HONG-KONG, CHINA.

Observatory.

Longitude from Greenwich, 7^h 36^m 41.86^s E.
Latitude, 22° 18′ 12.2″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Director: W. DOBERCK, Astronomer Royal.

INNSBRUCK, AUSTRIA.

Physikalisches Institut der K. K. Leopold Franzens Universität.

Longitude from Greenwich, 45^m 36^s E. (approximately).
Latitude, 47° 16′ 10″ N. (approximately).
Director: Prof. LEOPOLD PFAUNDLER.

IPSWICH, ENGLAND.

Orwell Park Observatory.

Longitude from Greenwich, 4^m 55.8^s E.
Latitude, 52° 0′ 33″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Proprietor: Colonel TOMLINE.
Astronomer: J. I. PLUMMER.

JENA, SAXE-WEIMAR.

Sternwarte.

Longitude from Greenwich, 46^m 17^s E.
Latitude, 50° 56′ 29″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Directors: J. F. POSSELT, 1820.
L. SCHRÖN, 1852.
E. ABBE, 1878.

Built in 1820, in the same garden where Schiller wrote Wallenstein.

JUVISY, FRANCE.

Private Observatory.

Longitude from Greenwich, 9^m 29^s E.
Latitude, 48° 41′ 36″ N.
Authority for longitude and latitude, A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Proprietor: C. FLAMMARION.

KALOCSA, HUNGARY.

Erzbischof Haynald's Observatorium.

Longitude from Greenwich, 1h 15m 54.28s E.
Latitude, 46° 31′ 41.25″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Directors: Dr. CHARLES BRAUN, S. J.
A. HÜNINGER.

The observatory was founded by Cardinal HAYNALD, Archbishop of Kalocsa, in 1878–'79.

KARLSRUHE, BADEN.

Grossherzogliche Sternwarte.

Longitude from Greenwich, 33m 22s E.
Latitude, 48° 59′ 44″ N.
Authority for longitude and latitude: Connaissance des Temps, 1884, p. xxvi.
Director: W. VALENTINER.

Transferred from MANNHEIM in 1879.

KASAN, RUSSIA.

Observatoria.

Longitude from Greenwich, 3h 16m 29.1s E.
Latitude, 55° 47′ 24″ N.
Directors: J. J. LITROW, 1814.
J. SIMONOFF, 1816.
M. LIAPOUNOFF, 1846.
M. KOWALSKI, 1854.
D. DOUBJAGO.

Founded in 1814 by the university. Constructed upon a very solid ancient structure; square tower, 23 feet (7 meters) in height. The southern gallery adjoins a wooden shed at its west angle, which has a movable roof. The building, with a portion of the instruments, was burned on the occasion of a fire which destroyed part of the town on the 5th September, 1842. Immediately restored.

KEMPSHOT, JAMAICA.

Observatory of Max. w. Hall.

Longitude from Greenwich, 5h 11m W.
Latitude, 18° 29′ N.
Authority, A. LANCASTER, Liste Générale, etc., 1887.
Director: ———.

Kensington, England.

Observatory.

Longitude from Greenwich, 46^s W.
Latitude, 51° 30′ 12″ N.
Authority for longitude and latitude: Connaissance des Temps. 1884 p. xv.

Kharkoff, Russia.

Observatoria.

Longitude from Greenwich, 2^h 24^m 54.7^s E.
Latitude, 50° 0′ 10.2″ N.
Directors: J. Fedorenko.
G. Levitzky.

Recently established.

Kiel, Prussia.

I. *Königliche Sternwarte.*

Longitude from Greenwich, 40^m 35.74^s E.
Latitude, 54° 20′ 28.6″ N.
Directors: C. A. F. Peters, 1873.
A. Krueger, 1881.

Founded in 1873, by the transfer of the observatory from Altona.

II. *Chronometer Observatorium der K. Marine.*

Longitude from Greenwich, 40^m 37.2^s E.
Latitude, 54° 20′ 3.3″ N.
Authority for longitude and latitude: A. Lancaster Liste Générale des Observatoires et Astronomes, 1887
Director: C. F. W. Peters.

Kieff, Russia.

Observatoria.

Longitude from Greenwich, 2^h 2^m 0.7^s E.
Latitude, 50° 27′ 11.12″ N.
Directors: —— Feadorow, 1838.
A. Schidloffsky, 1855.
M. K. Khandrikoff, 1872.

Established in 1838 as an annex to the university.

Kingston, Canada.

Observatory.

Longitude from Greenwich. 5^h 5^m 56.4^s W.
Latitude, 44° 13′ 25.2″ N.
Authority for longitude and latitude: A. Lancaster, Liste Générale des Observatoires et Astronomes, 1887.
Director: J. Williamson.

KIS-KARTAL, HUNGARY.

Sternwarte der Baronesse von Podmaniczky.

Longitude from Greenwich, $1^h\ 18^m\ 13^s$ E.
Latitude, 47° 42′ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Director: R. VON. KÖVESLIGETHY.

KILMARNOCK, SCOTLAND.

Observatory.

Longitude from Greenwich, $18^m\ 10.5^s$ W.
Latitude, 55° 36′ 40″ N.
Directors: THOMAS MORTON, 1818.
THOMAS LEE, 1862.

Erected in 1818 by the late Mr. MORTON, H. M. R. S. S. A., at an expense of about £1,500, and is now the property of THOMAS LEE, F. R. A. S. Its height is 70 feet, and being at an elevated situation, it commands an extensive and delightful view.

KLAUSENBURG, HUNGARY.

Sternwarte.

Longitude from Greenwich, ———.
Latitude, ———.
Director: CARL JUSZTA.

KJÖBENHAVN (COPENHAGEN), DENMARK.

Universitets Astronomiske Observatorium.

Longitude from Greenwich, $50^m\ 19.2^s$ E.
Latitude, 55° 41′ 13.6″ N.
Directors: C. LUMBORG, 1637.
T. BARTHOLIN, 1647
O. ROEMER, 1681.
PETER I. HORREBOW, 1714.
C. HORREBOW, 1753.
T. BUGGE, 1777.
H. C. SCHUMACHER, 1815.
VON CAROE, 1822.
C. F. R. OLUFSEN, 1832.
H. D'ARREST, 1856.
T. N. THIELE, 1876.

Founded in 1637, but only completed in 1656. The first edifice was destroyed by fire on the 20th of October, 1728. The observatory was re-established in the round tower belonging to the university. In 1820 a wooden addition was made to it on the Holken bastei. Finally, in 1857, it was reorganized and removed to the glacis of the fortress between the citadel and the Osterthor (eastern gate).

KÖLN, PRUSSIA.

Sternwarte.

Longitude from Greenwich, 27m 51s E.
Latitude, 50° 55′ 31″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Director: Dr. HERMANN KLEIN.

KÖNIGSBERG, PRUSSIA.

Universitäts Sternwarte.

Longitude from Greenwich, 1h 21m 58.91s E.
Latitude, 54° 42′ 50.6″ N.
Directors: Z. W. BESSELS, 1811.
A. L. BUSCH, 1849.
M. L. G. WICHMANN 1866.
E. LUTHER, 1880.

Constructed in 1811 on one of the most elevated points of the ramparts to the northwest of the town. A main building divided into two great halls—a northern and a southern. Two wings—one the meridian hall, the other an addition. With the use of a meridian circle BESSELS and his assistants accomplished the work known as the "Königsberger Zonen." This great undertaking was begun August 19, 1821, and finished January 21, 1833.

KRAKAU, AUSTRIA.

K. K. Universitäts Sternwarte.

Longitude from Greenwich, 1h 19m 50.5s E.
Latitude, 50° 3′ 50″ N.
Directors: Dr. J. B. SNIADECKI, 1791–1803.
Dr. J. I. LITTROW, 1807–1809.
Dr. J. LESKI, 1811–1825.
Dr. MAX WEISSE, 1826–1861.
Dr. F. M. KARLINSKI, 1862.

The observatory, established in 1791 and partially reconstructed in 1858, lies in the botanical garden at the eastern extremity of the city. The building, two and one-half stories high, with two domes, was originally not intended for an observatory, and it is impossible to mount in them any larger modern instrument.

Kremsmünster, Austria.

Sternwarte der Benediktiner Abtei.

Longitude from Greenwich, 56^m 31.6^s E.
Latitude, 48° 3′ 23.8″ N.
Directors: A. Desing, 1748.
P. Fixlmillner, 1761.
T. Derfflinger, 1791.
B. Schwarzenbrunner, 1824.
M. Koller, 1830.
A. Reslhuber, 1847.
G. Strasser, 1875.
C. Wagner.

Founded in the convent of the Benedictines in 1748; built in the convent garden at the northern extremity of the buildings. The observatory consists of a massive tower eight stories high, with two wings of five stories.

Kronstadt, Russia.

Morskaia Astronomicheskaia Observatoria.

Longitude from Greenwich, 1^h 59^m 3.60′ E.
Latitude, 59° 59′ 24.2″.
Authority for longitude and latitude: V. Fuss.
Directors: L. Hübner, 1857.
V. Fuss, 1871.

Observatory of the school of pilots.

La Plata, Argentine Republic.

Observatory.

Longitude from Greenwich. ——.
Latitude, ——.
Director: F. C. Beuf.

Leipzig, Saxony.

I. *Universitäts Sternwarte.*

Longitude from Greenwich, 49^m 34.02^s E.
Latitude, 51° 20′ 6.3″ N.
Directors: C. F. Rüdiger, 1794.
K. B. Mollweide, 1811.
A. F. Moebius, 1816.
C. A. Jahn, 1845.
C. C. Bruhns, 1860.
H. Bruns, 1883.

Constructed from 1787 to 1794, upon the great tower of the castle of Pleissenburg. A new observatory, situated at the extreme end of one of the suburbs, took the place of the old one in 1861.

II. *Private Sternwarte des Herrn Rudolph Engelmann.*

Longitude from Greenwich, 49^m 38^s E.
Latitude, 51° 20′ 7″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Director: Dr. RUDOLF ENGELMANN.

LEMBERG, AUSTRIA.

Sternwarte der Technischen Hochschule.

Longitude from Greenwich, ——.
Latitude, ——.
Director: ——.

The observatory is used for geodetic purposes.

LEYDEN, HOLLAND.

Rijks Observatorium.

Longitude from Greenwich, 17^m 56.35^s E.
Latitude, 52° 9′ 20.2″ N.
Directors: J. GOLIUS, 1632.
S. C. KECHEL, 1667.
C. MELDER, 1668.
B. DE VOLDER, 1682.
L. ZUMBACH DE KOESFELD, 1705.
W. J. S'GRAVESANDE, 1717.
J. LULOFS, 1742.
D. VAN DE WIJNPRESSE, 1768.
P. NIEUWLAND, 1794.
J. A. FAS, 1797.
J. F. VAN BEEK-CALKOEN, 1799.
C. E. KAMA, 1812.
F. KAISER, 1837.
H. G. VAN DE SANDE BAKHUIJZEN, 1872.

Founded in 1632. The most ancient of existing observatories in Europe. Originally built as a great tower for the town clock; enlarged in 1689; repaired in 1817. In 1858 a new observatory was commenced, and completed in 1860.

LEYTON, ENGLAND.

Barclay Observatory. (*Private.*)

Longitude, 0.87^s W.
Latitude, 51° 34′ 34″ N.
Authority for longitude and latitude: Ordnance survey.
Proprietor: J. GURNEY BARCLAY.
Observer: CHARLES GEORGE TALMAGE, F. R. A. S.

INSTRUMENTS:

(*a*) *Meridian circles:* Makers, HOUGHTON and SIMMS; diameter of circles, 36 inches, divided to 5′; read by 4 microscopes to 0.1″; aperture of objective, 4 inches; for observations of the sun aperture employed, 4 inches; magnifying power ordinarily employed, 80 diameters.

(*c*) *Equatorial instrument:* Maker, COOKE, York; aperture of objective, 10 inches; magnifying power of eye-pieces, 70 to 1200.

(*g*) *Clock:* Sidereal; maker, SIMMONDS, London.

LIEGE, BELGIUM.

Institut Astronomique de l'Université.

Longitude from Greenwich, 22^m 12^s E.
Latitude, 50° 37′ 0.6″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Director: F. FOLIE.

LISBON, PORTUGAL.

I. *Real Observatorio Astronomico de Lisbon* (*Ajuda*).

Longitude from Greenwich, 36^m 44.68^s W.
Latitude, 38° 42′ 31.3″ N.
Director: F. A. OOM, 1878.

The Royal Observatory is situated in the Ajuda Park (Tapada da Ajuda), about 1,300 meters west of Lisbon. It had its origin in 1857, when the late King, D. PEDRO V, made a first donation of 30,000 milreis for the establishment of an astronomical observatory.

The building was commenced in 1861. It consists of a central two-story octagonal structure, surmounted by a revolving tower 11 meters in diameter, containing the great equatorial, with four one-story wings, corresponding to the cardinal points of the compass. In the southern wing is the principal entrance, with a peristyle and vestibule which communicates with the lower and upper stories of the central structure.

The whole length of the building is 67.1 meters E—W. Its breadth is 42 meters.

A three-story dwelling-house for the personnel is built 36.5 meters east of the observatory. A part of its ground floor is occupied by a mechanical workshop for repairs and modifications in the instruments

The organization of the observatory dates from May, 1878. According to its statute the observatory is chiefly destined to the progress of sidereal astronomy.

II. *Observatorio da Marinha.*

Longitude from Greenwich, $36^m\ 33.5^s$ W.
Latitude, 38° 42′ 17.6″ N.
Directors: M. E. S. LIMPE.
A. CONTO VALENTE.
J. CORDEIRO FEIJO.
F. FOLQUE.
F. DE PAULA FERREIRA DE MESQUITA, 1874.

Established in 1798. Renewed in 1859 and 1874.

III. *Observatorio Astronomico na Escola Polytecnica.*

Longitude, ———.
Latitude, ———.
Director: ———.

For the instruction of students only.

LIVERPOOL, ENGLAND.

Observatory.

Longitude from Greenwich, $12^m\ 17.2^s$ W.
Latitude, 53° 24′ 3.8″ N.
Director: J. HARTNUP, 1845.

Founded in 1838 by the municipal council; completed in 1848. Transferred to Birkenhead, on the opposite bank of the Mersey, in 1867. It is provided with an apparatus for the examination of chronometers where the temperature can be raised by means of a gas heater. The equatorial is moved by clock-work, set in motion by hydraulic power. The time-signal is given to the shipping by the firing of a cannon.

LONDON, ENGLAND.

Tulse Hill Observatory (Upper Tulse Hill, London, S. W.).

Longitude from Greenwich, 27.7^s W.
Latitude, 31° 26′ 47″ N.
Director: WILLIAM HUGGINS.

Founded in 1856.

INSTRUMENTS:

An equatorial instrument by GRUBB, of Dublin, so constructed that either a refractor, of 15 inches aperture and 15 feet focal length, or a CASSEGRAIN reflector with metallic speculum of 18 inches aperture may be placed at pleasure on the same equatorial mounting, so that with either instrument the circles read sufficiently for the finding of objects. The driving-clock has, in addition to the usual governor balls, a secondary control of a pendulum in electrical connection with a standard clock.

Up to 1870, when the present equatorial was erected, a transit circle of 3¼ inches aperture was mounted in the observatory. At that time the principal instrument the observatory contained was an 8-inch refractor by ALVAN CLARK, mounted equatorially by COOKE, of York.

There is a fine sidereal clock by ARNOLD, and various spectroscopes for use, with the telescopes, on the sun and stars; and there has been recently added a spectroscope, with Iceland spar prism and quartz lenses, for photography of spectra of stars.

Underneath the observatory are two rooms, one devoted to chemistry and photography, the other to physical experiments in connection with spectrum analysis.

LOUVAIN, BELGIUM.

I. *Observatoire des Collège de la Compagnie de Jésus.*

Longitude from Greenwich, $18^m\ 48^s$ E.
Latitude, 50° 53′ 27″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Director: J. THIRION, S. J.

II. *Private Observatory of Dr. Terby.*

Longitude from Greenwich, $18^m\ 51^s$ E.
Latitude, 50° 52′ 40″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Director: Dr. TERBY.

LÜBECK, GERMANY.

Sternwarte.

Longitude from Greenwich, $42^m\ 45.7^s$ E.
Latitude, 53° 51′ 31.2″ N.
Director: ED. THIEL.

Founded in 1860 as an annex to the navigation school. The tower, with a revolving turret of 20 feet diameter, stands upon the ramparts to the south of the town 63 feet above the level of the Baltic.

LUCKNOW, INDIA.

Observatory.

Longitude from Greenwich, $5^h\ 23^m\ 24.02^s$ E.
Latitude, 26° 51′ 10″ N.
Authority for longitude and latitude: Annuaire des Bureau des Longitudes, 1884, p. 412.

LUND, SWEDEN.

Lund Observatory.

Longitude from Greenwich, $52^{m}\ 45.02^{s}$ E.
Latitude, 55° 41′ 52.05″ N.
Authority for longitude and latitude: Undersökning af Meridiancirkeln på Lunds Observatorium jemte bestämming af den sammas polhöjd af AND. LINDSTEDT. Bestimmung der Längen-Differenz Zwischen Berlin und Lund, auf telegraphischem Wege ausgeführt im Jahre 1868. Herausgegeben von C. BRUHNS.

Directors: ———.
A. LINDGREEN, 1786.
——— ———, 1815.
J. M. AGARDH, 1847.
AXEL MÖLLER, professor of astronomy.

Founded as a dependency of the University about 1760. Reorganized in 1866.

INSTRUMENTS:

(*a*) *Meridian circle:* One; makers, A. & G. REPSOLD, in Hamburg; diameter of circles, 39 inches (1 meter); divided to 2′; read by 4 microscopes to 0.1″; aperture of objective, 6½ inches (163^{mm}); magnifying power ordinarily employed, 173 diameters.

(*c*) *Equatorial instruments:* Makers, G. & S. MERZ, in Munich, and E. JÜNGER, in Copenhagen; aperture of objective, 9½ inches (245^{mm}); magnifying powers of eye-pieces, 80 to 1,300 diameters. (*c′*) Makers, A. STEINHEIL, in Munich, and E. JÜNGER, in Copenhagen; aperture of objective, 4¼ inches (108^{mm}); magnifying powers of eye-pieces, 16 to 200 diameters.

(*d*) *Universal spectroscope* by G. & S. MERZ, in Munich, with 3 sets of prisms *à vision directe*. (*d*) *Simple spectroscope* by HEUSTREU, in Kiel, constructed after the indication of Professor VOGEL, in Potsdam.

(*f*) *Chronograph:* One by MAYER & WOLF, in Vienna.

(*g*) *Clocks:* Sidereal time; one, maker, KESSELS, in Altona: one, maker, TIEDE, in Berlin.

(*h*) *Chronometer:* Mean time; maker, KESSELS, in Altona.

(*i*) One universal instrument by REPSOLD, in Hamburg; 3 telescopes by DOLLOND, MERZ, and PLÖSSL.

LYME REGIS (DORSET), ENGLAND.

Observatory of C. E. Peek.

Longitude from Greenwich, $44^{m}\ 56.02^{s}$ W.
Latitude, 50° 42′ 12″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887, p. 35.
Director: C. E. PEEK.

LYONS, FRANCE.

Astronomical and Meteorological Observatory.

Longitude from Greenwich, 19m 18s E.
Latitude, 47° 41′ 14″ N.
Director: C. ANDRÉ, 1877.

There was an observatory in existence in the eighteenth century at the Jesuit College, where Fathers BONNET, BÉRAULD, LEFÈVRE, and LAPON made observations. The new observatory was founded in 1877.

INSTRUMENTS:

(*a*) *Meridian circle:* Maker, EICHENS; diameter of circles, 23½ inches (0m.60), divided to 5′; read by 4 microscopes to 0.1″; aperture of objective, 6 inches; for observations of the sun, aperture employed, 6 inches; magnifying power ordinarily employed, 300 diameters.

(*b*) *Meridian transit instrument:* Maker, RIGAUT; aperture, 2 inches; magnifying power, 150 diameters.

(*g*) *Clocks:* Two sidereal; makers, BRÉGUET & RÉDIER, Paris.

(*h*) *Chronometers:* Mean time; makers BRÉGUET, Paris: sidereal; maker, BRÉGUET, Paris.

MADRAS, INDIA.

Madras Observatory.

Longitude from Greenwich, 5h 20m 59.33s E.
Latitude, 13° 4′ 8.1″ N.
Directors: J. GOLDINGHAM, 1787.
—— —— WARREN (intermediate), 1805.
J. GOLDINGHAM, 1811.
S. G. TAYLOR, 1830.
W. S. JACOB, 1848.
—— WORSTER (intermediate), 1854.
W. S. JACOB, 1855.
J. F. TENNANT, 1860.
N. R. POGSON (Astronomer Royal), 1860.

Founded in 1787 by the East India Company.

MADRID, SPAIN.

Observatorio de Madrid.

Longitude from Greenwich, 14m 45.5s W.
Latitude, 40° 24′ 29.7″ N.
Directors: J. CARONADO, 1790.
J. RODRIGUEZ, 1817.
—— BAVIA, 1821.
D. FONTAN, 1835.
PALO MARUZ, 1850.
A. AGUILAR, 1860.
M. MERINO.

Established at Buen Retiro in 1790. When the French occupied Madrid in 1808, they set up a battery at that place, and the instruments were destroyed by fire. The observatory then abandoned was not restored until 1846. In 1852 the grounds were enlarged, and a pavillion with a revolving turret was erected.

MANILA, PHILIPPINE ISLANDS.

Observatorio del Ateneo Municipal.

Longitude from Greenwich, $8^h\ 3^m\ 48.6^s$ E.
Latitude, 14° 35′ 25″ N.
Directors: P. FRANCISCO COLINA, 1865–1866.
P. FEDERICO FANRA, 1866–1871.
P. JOSÉ CANUDAS, 1871–1873.
P. JOSE MINORES, 1873–1877.
P. FRANCISCO SANCHEZ, 1877–1878.
P. FEDERICO FANRA, 1878.

The observatory was founded in 1865. In the year 1859 T. **VERNACAI** projected an observatory in which he should be intrusted with the hydrographic commission for this archipelago. With this object in view instruments were purchased, but never mounted by the hydrographic commission, and remained in the observatory of the municipal Athenæum from 1865 to 1873.

MANNHEIM, BADEN.

Grossherzogliche Sternwarte.

Longitude from Greenwich, $35^m\ 50.52^s$ E.
Latitude, 45° 29′ 11″ N.
Directors: C. MARGER, 1764.
K. J. KÖNIG, 1783.
J. N. FISCHER, 1786.
P. UNGESCHICK, 1788.
R. BARRY, 1788.
H. C. SCHUMACHER, 1813.
F. B. G. NICOLAI, ——.
A. M. NELLE, 1852.
E. SCHÖNFELD, 1859.
W. VALENTINER, 1875.

First established in the electoral castle of **SCHWETZINGEN**, 6¼ miles (10 kilometers) from Mannheim, and in 1772 removed to the west of the town where it was located in a tower 105 feet (32 meters) in diameter, with remarkably thick walls.

Transferred to KARLSRUHE in 1879. (See KARLSRUHE.)

MARBURG, GERMANY.

Sternwarte.

Longitude from Greenwich, 35^m 5^s E.
Latitude, 50° 48′ 46.9″ N.
Director : DR. MELDE.

MARKREE, COUNTY SLIGO, IRELAND.

Markree Observatory.

Longitude from Greenwich, 33^m 48.4^s W.
Latitude, 54° 10′ 31.8″ N.
Directors : E. J. COOPER, 1832–1863.
W. DOBERCK, 1875.

Founded by E. H. COOPER, M. P., and built in the park of Markree.

MARSEILLES, FRANCE.

Observatoire.

Longitude from Greenwich, 21^m 34.64^s E.
Latitude, 43° 18′ 19.1″ N.
Directors : A. F. LAVAL, 1702.
E. PERENAS, 1728.
G. SAINT JACQUES DE SILVABELLE, 1764.
J. J. C. SHULIS, 1793.
—— BLANPAINT, 1811.
J. F. A. GAMBART, 1822.
B. VALZ, 1835.
E. STEPHAN, 1868.

The Society of Jesus had an observatory at their College of Sainte Croix, founded 1702. In 1849 this scientific institution was taken in hand by the ministery of marine. It is a three-story building, longest from east to west, erected on the summit of the Butte des Moulins. In 1797 this observatory was repaired. A new establishment was erected in 1869 on the hill of Longchamps, to supplement the work at the Paris observatory. The instruments are distributed in separate apartments.

MELBOURNE, VICTORIA.

Melbourne Observatory.

Longitude from Greenwich, 9^h 39^m 54.8^s E.
Latitude, 37° 49′ 53.4″ S.
Director : R. L. J. ELLERY, F. R. S., F. R. A. S.

Proposed first in 1853, and established, to begin with, at Williamstown. Transferred to Melbourne in 1861. Building completed in 1863.

MERAN (TYROL), AUSTRIA.

Astro-Physikalisches Observatorium.

Longitude from Greenwich, ——.
Latitude, ——.
Director: ——.

MEUDON (PARIS), FRANCE.

Observatoire d'Astronomie—Physique.

Longitude from Greenwich, 8^{m} 55.6^{s} E
Latitude, 48° 48′ 18″ N.
Director: J. **JANSSEN**, 1875.

INSTRUMENTS:

A parallactic apparatus bearing two twin telescopes to be used conjointly; 1, a photographic telescope of 81 centimeters aperture and 16 or 17 meters focal length, for astronomy and spectroscopy; 2, a photographic telescope of the same focus and 62 centimeters aperture.

A 5-inch photographic telescope (images 30 centimeters).

A reflector, 1 meter in diameter and 3 meters focal length.

A series of various instruments for the study of absorption of gases and vapors, scales, etc.

MEXICO, MEXICO.

Observatorio.

Longitude from Greenwich, 6^{h} 36^{m} 26.67^{s} W.
Latitude, 19° 26′ 1.3″ N.
Director: F. **JIMENEZ**.
M. **BARCENA**.

Founded in 1877.

MILAN, ITALY.

R. Osservatorio Astronomico di Brera.

Longitude from Greenwich, 36^{m} 45.97^{s} E.
Latitude, 45° 27′ 59.4″ N.
Directors: L. **LAGRANGE**, 1763.
F. **REGGIO**, 1777.
B. **ORIANI**, 1804.
F. **CARLINI**, 1833.
G. V. **SCHIAPARELLI**, 1862.

The observatory was founded in 1763. In the beginning it consisted of an octagonal structure to which, in 1775, two side towers were added.

In 1760 a telescope of 33 feet (10 meters) focal distance was mounted in the College of the Brera by P. **BOVIO** and D. **GERRA**.

MODENA, ITALY.

Osservatorio.

Longitude from Greenwich, $43^m\ 42.9^s$ E.
Latitude, 44° 38′ 52.8″ N.
Director: D. RAGONA.

MONCALIERI, ITALY.

Osservatorio del R. Collegio Carlo Alberto.

Longitude from Greenwich, $0^h\ 30^m\ 44.0^s$ E.
Latitude, 44° 59′ 58.6″ N.
Authority for longitude and latitude: R. Institue—military topographer.
Director: P. FRANCESCO DENZA, 1859.

MONTREAL, CANADA.

McGill College Observatory.

Longitude from Greenwich, $4^h\ 54^m\ 18.54^s$ W.
Latitude, 45° 31′ N.
Director: C. McLEOD.

MONTSOURIS (PARIS), FRANCE.

Observatoire du Bureau des Longitudes.

Longitude from Greenwich, $9^m\ 20.68^s$ E.
Latitude, 48° 49′ 18″ N.
Directors: E. MOUCHEZ, 1875.
Dr. MARIE DAVY.

Founded in 1875 by the department of marine, in the southwest corner of the park of Montsouris at the southern extremity of Paris.

MOSCOW, RUSSIA.

Observatory of the Imperial University.

Longitude from Greenwich, $2^h\ 30^m\ 16.9^s$ E.
Latitude, 55° 45′ 19.8″ N.
Authority for longitude and latitude, Nautical Almanac.
Directors: M. PANKEVICH, 17—.
C. F. GOLDBACH, 1804.
M. PANKEVICH, 1811.
M. TSCHOUMAKOFF, 1814.
D. PEREVOSTSCHIKOFF, 1823.
A. DRASCHOUSSOFF, 1847.
K. G. SCHWEITZER, 1856.
Prof. Dr. THEODORE BREDICHIN, 1876.

INSTRUMENTS:

(*a*) *Meridian circle:* One; maker, REPSOLD, in Hamburg; diameter of circle, 36 inches; divided to 2′; read by 4 microscopes to 0.1″; aperture of objective, 5.3 inches; magnifying power ordinarily employed, 100 diameters.

(*c*) *Equatorial instrument:* Maker, MERZ, in Munich; aperture of objective, 10.7 inches; magnifying power of eye-pieces, 100 to 1,200. (*c′*) Photoheliograph of DALMAYER, in London.

(*d*) Universal spectroscope of MERZ, in Munich; direct vision with 10 prisms and micrometer.

(*e*) One photometer of ZÖLLNER.

(*f*) *Chronograph:* of SIEMENS and HALSKE.

(*g*) *Clocks:* Mean time, two; makers, TIEDE, UTZSCHNEIDER; sidereal, two; makes, KESSELS, TOLSTOI.

(*h*) *Chronometers:* Mean time, two; maker, DENT; sidereal, two; makers, DENT, KESSELS.

(*i*) *Miscellaneous:* Transportable transit instruments, theodolites, universal instruments, etc.

MÜNCHEN, BAVARIA.

Königliche Sternwarte, Bogenhausen.

Longitude from Greenwich, 46m 26.13s E.
Latitude, 48° 8′ 45.5″ N.
Directors: K. F. VON SEYFFER, 1809.
J. VON SOLDNER, 1819–1833.
Prof. Dr. J. VON LAMONT, 1833–1879.
Dr. SEIDEL (provisory).
Prof. Dr. H. SEELIGER, October, 1882.

Founded in 1809, on the hill of Bogenhausen, near Munich; a main building of one story, facing east and west; two wings extend toward the north. An edifice designed for the purpose was put up in the garden for a great refractor, by the aid of which LAMONT made his observations of the satellites of Saturn and of the nebulæ.

MUNICH, BAVARIA. (See MÜNCHEN.)

MÜNSTER, PRUSSIA.

Sternwarte.

Longitude from Greenwich, 30m 31s E.
Latitude, 51° 58′ 10″ N.
Authority for longitude and latitude: Connaissance des Temps, 1884, p. xxvii.
Directors: E. HEIS, 1852–1877.
Professor STURM.

Founded in 1852, in the neighborhood of the academy (high school).

NAPLES, ITALY. (See NAPOLI.)

NATAL, SOUTH AFRICA.

Natal Observatory.

Longitude from Greenwich, ——.
Latitude, ——.
Director: ——.

NAPOLI, ITALY.

R. Osservatorio, Capo di Monte.

Longitude from Greenwich, 57^m 0.9^s E.
Latitude, 40° 51′ 45.4″ N.
Directors: G. CASELLA, 1791.
F. M. DA PRADO, 1808.
F. ZUCCARI, 1812.
C. BRIOSCHI, 1818.
E. CAPOCCI, 1833.
LEOPOLDO DEL RE, 1849.
—— CAPOCCI, 1860.
A. DE GASPARIS, 1864.

Proposed in 1788. The buildings begun at the northeast corner of the Palace of the Library (Palazzo della Biblioteca) and Royal Museum (Museo Reale) were left incomplete in 1790. In 1809 one of the towers of the old convent of San Gaudioso was appropriated to this object. In 1812 was laid the first stone of a new observatory on the hill of Miradois, at the point called Capo di Monte. The instruments were mounted in 1819. Nine asteroids have been discovered at this observatory.

NEUCHATEL, SWITZERLAND.

Observatoire Cantonal.

Longitude from Greenwich, 27^m 50.2^s N.
Latitude, 46° 59′ 51″ N.
Director: A. HIRSCH, 1858.

Founded in 1857. A rectangular structure of 88½ feet by 26¼ feet (27 by 8 meters) and 19½ feet (6 meters) in height; a tower with a revolving turret.

NICE, FRANCE.

Observatoire.

Longitude from Greenwich, 29^m 12.3^s. E.
Latitude, 43° 43′ 16.9″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Director: J. PERROTIN.

This observatory was erected at the expense of BISCHOFSHEIM.

NICOLAEV, RUSSIA.

Nicolaevskaia Observatoria.

Longitude from Greenwich, $2^h\ 7^m\ 54.1^s$ E.
Latitude, 46° 58′ 20.6″ N.
Authority for longitude: Telegraphic determination of 1877; for latitude, K. KNORRE, Astron. Nach. VII, p. 261.
Directors: K. F. KNORRE, 1821.
J. KORTAZZI, 18—.

Founded in 1821; completed in 1826.

INSTRUMENTS:

(*a*) *Meridian circle:* Maker, ERTEL, in Munich; diameter of circle, 38 inches; divided to 3′; read by four microscopes to 1″; aperture of objective, 4.2 inches; magnifying power ordinarily employed, 100 diameters.

(*c*) *Equatorial instrument:* Makers, REPSOLD & SONS, in Hamburg; aperture of objective, 9½ inches; magnifying powers of eye-pieces, 100, 150, 330, 476, 666.

(*f*) *Chronograph:* One of HERBST, in Pulkowa.

(*g*) *Clocks:* One mean time; maker, KESSELS, No. 1282; one sidereal; makers, BARRAUD, No. 769, and HOHVIN, No. 24.

(*h*) *Chronometers:* Mean time, 89, of different makers; sidereal, 3, of different makers.

(*i*) *Miscellaneous:* One transportable transit instrument of HERBST, in Pulkowa, for the determination of time in the vertical of Polaris; aperture 2.7 inches; magnifying power, 100.

(*k*) One transportable vertical circle, 11 inches; aperture, 1.9 inches; circle divided to 4′; read by two microscopes to 2″.

NOTTINGHAM, ENGLAND.

Private Observatory.

Longitude from Greenwich, $6^m\ 0^s$ W.
Latitude, 52° 58′ 24″.
Director: THOMAS W. BUSH, F. R. A. S.

The observatory is a provisional structure of wood, built in 1876, and comprising equatorial room of 12 feet diameter and small transit annex.

ODESSA, RUSSIA.

I. *Sternwarte.*

Longitude from Greenwich, $2^h\ 3^m\ 2.5^s$ E.
Latitude, 46° 28′ 36″ N.
Authority for longitude: E. BECKER and E. BLOCK, telegraphic determination of the longitude between Berlin and Odessa in 1876; for latitude: observations with the meridian circle.
Directors: L. BERKEWITSCH, 1871; 1881.
E. BLOCK, 1873.

II. *Sternwarte des Herrn L. Hildesheimer.*

Longitude from Greenwich, ——.
Latitude, ——.
Director: L. HILDESHEIMER.

OFEN, AUSTRIA-HUNGARY. (*See* BUDAPEST.)

O-GYALLA, HUNGARY.

Astro-physikalisches Observatorium.

Longitude from Greenwich, $1^h\ 12^m\ 45.59^s$ E.
Latitude, 47° 52′ 43.4″ N.
Director: Dr. N. DE KONKOLY.

OLMÜTZ, AUSTRIA.

Sternwarte.

The observatory at Olmütz was owned by the RITTER VON UNKRECHTSBERG, with Dr. J. SCHMIDT (later at Athens) as director. With the owner's death, in 1869, the observatory was discontinued.

OXFORD, ENGLAND.

I. *Radcliffe Observatory.*

Longitude from Greenwich, $5^m\ 2.6^s$ W.
Latitude, 51° 45′ 35″ N.
Directors: T. HORNSBY, 1771.
A. ROBERTSON, 1810.
S. P. RIGAUD, 1827.
M. J. JOHNSON, 1839.
R. MAIN, 1860.
E. J. STONE, 1878.

Founded in 1772 by the trustees of Dr. JOHN RADCLIFFE, on ground donated by the DUKE OF MARLBOROUGH. A large tower containing library, etc., and two wings, east and west, for meridian instruments, computing-rooms, etc. Detached buildings for equatorial instruments. Dwelling-house for the director.

II. *Oxford University Observatory* (*Savilian Observatory*).

Longitude from Greenwich, $5^m\ 0.4^s$ W.
Latitude, 51° 45′ 34.2″ N.
Director: C. PRITCHARD.
Founded in 1873.

PADOVA, ITALY.

Osservatorio Astronomico dell' Università.

Longitude from Greenwich, $47^m\ 29.13^s$ E.
Latitude, 45° 24′ 2.5″ N.
Directors: G. **TOALDO**, 1761.
V. **CHIMINELLO**, 1797.
G. **SANTINI**, 1813.
G. **LORENZONI**, 1877.

Founded in 1761 by the Venetian senate, and accommodated in a massive tower built in the thirteenth century by the tyrant Ezzelino for a state prison.

PADUA, ITALY. (*See* PADOVA.)

PAISLEY, SCOTLAND.

Observatory of T. Coats.

Longitude from Greenwich, $17^m\ 43.3^s$ W.
Latitude, 55° 50′ 43.8″ N.
Authority for longitude and latitude: A. **LANCASTER**, Liste Générale des Observatoires et Astronomes, 1887.
Observer, D. **MACLEAN**.

PALERMO, ITALY.

R. Osservatorio.

Longitude from Greenwich, $53^m\ 25^s$ E.
Latitude, 38° 6′ 44″ N.
Authority for longitude and latitude: **PIAZZI DAUSSY**, 1835, p. 21. In Connaissance des Temps, 1884, p. xxxiv.
Directors: G. **PIAZZI**, 1787.
N. **CACCIATORE**, 1817.
G. **CACCIATORE**, 1842.
D. **RAGONA**, 1858.
G. **CACCIATORE**, 1860.

Proposed in 1786. Established in the Saint Ninfa tower of the Royal Palace, the ancient residence of the Emirs during the Arabian dominion. The first complete vertical circle made by **RAMSDEN**, and finished in 1789, was mounted in this observatory. **PIAZZI** used it from 1792 to 1813 for the observations which served him as a basis for his famous catalogue. Ceres was discovered at Palermo on the first day of the nineteeth century.

PARAMATTA, NEW SOUTH WALES, AUSTRALIA.

Private Observatory.

Longitude from Greenwich, $10^h\ 4^m\ 6.2^s$ E.
Latitude, 33° 48′ 49.8″ W.

Established by **BRISBANE**. Its instruments went to the Government Observatory at Sydney, New South Wales.

PARIS, FRANCE.

I. *Observatoire Nationale.*

Longitude from Greenwich, $9^m\ 21.02^s$ E.
Latitude, 48° 50′ 11.8″ N.

Directors: J. D. CASSINI, 1671.
J. CASSINI, 1712.
C. F. CASSINI (de Thury), 1756.
J. D. CASSINI (de Thury), 1784.
J. J. L. DE LA LANDE, 1795.
P. MÉCHAIN, 1801.
A. BRUNARD, 1804.
D. F. J. ARAGO, 1811.
U. J. J. LE VERRIER, 1853.
C. E. DELAUNAY, 1871.
U. J. J. LE VERRIER, 1872.
E. MOUCHEZ, 1878.

National Observatory (formerly royal, since imperial), built in 1667, under the auspices of the Academy of Sciences, according to plans of C. PERRAULT. A vast central hall; two towers, east and west. In 1732 a small room to accommodate a mural quadrant was added beyond the eastern tower, and in 1742 this was extended by a second inclosure for a movable quadrant. In 1760 a turret, with a revolving roof, was built to the south of this addition. The main building, having become dilapidated, was restored in 1786, completed 1793; since when it has been detached and the south terrace built. In 1832 the small rooms where observations are taken were repaired, and the amphitheater and a rotunda with a revolving roof built upon the principal terrace. The dome intended for the shelter of the great equatorial was placed on the summit of the building in 1850. The great telescope, with a mirror of silvered glass, 4 feet (1.2^m) in diameter, was mounted in 1876, in a building on the ground-floor level. JOHN DOMINIC CASSINI discovered four of the satellites of Saturn at the Paris observatory, and also first investigated the subject of the zodiacal light, and here, too, the great grandson of this astronomer was the first to follow the variations of the magnetic needle with minute and persevering industry; and it was here that ARAGO and MATHIEU demonstrated the extremely small parallax of the stars.

A large number of astronomical manuscripts, containing matter of great interest, are preserved at the Paris observatory.

II. *Observatoire du Bureau des Longitudes.*

(See MONTSOURIS.)

PARMA, ITALY.

R. Osservatorio Astronomico.

Longitude from Greenwich, 41^m 20^s E.
Latitude, 44° 48′ 15″ N.
Director : ——.

PARSONSTOWN, IRELAND. (See BIRR CASTLE.)

PEKIN, CHINA.

Observatory.

Longitude from Greenwich, 7^h 45^m 37.02^s E.
Latitude, 39° 54′ 13″ N.
Authority for longitude and latitude: Annuaire Bureau des Longitudes, Paris, 1884, p. 414.

PESARO, ITALY.

Observatory.

Longitude from Greenwich, 51^m 38^s E.
Latitude, 43° 55′ 27″ N
Directors: LUIGI GUIDI.
PIO CALVORI, 1883.

Prof. LUIGI GUIDI, who was the founder of this observatory, who for many years very ably filled the place of its director, and to a great extent maintained it at his own expense, died on the 6th March, 1883.

The municipality of PESARO, which already owned the property and a considerable portion of the scientific apparatus, by an agreement with Mr. GEROLAMO GUIDI, the son of the deceased Professor GUIDI, took possession of the observatory and temporarily appointed Sr. CALVORI as director.

INSTRUMENTS.

(*a*) *Astronomical division* :

(1) A small equatorial by MERZ, with an opening of 12 centimeters, very simply mounted, for cosmographic observations, with a *Merz* helioscope with three reflectors and a HOFMANN spectroscope.

(2) A perfectly good transit instrument in an adjoining room, with a meridian opening, firmly imbedded in Istrian rock.

(3) Two chronometers, one a marine chronometer (English), and the other with a pendulum (HIPP).

(*b*) *Meteorological division :*

(1) Barometers for direct observations.

(2) A meteorological case with termographs, psychrometer, hygrometer, evaporometer for direct observation.

(3) Registering apparatus for various meteorological data, barometric pressure, temperature, hygrometric state of the air, velocity and direc-

tion of the wind and rain. These apparatus, some mechanical and a few electric, are in duplicate, so that there may be no interruption of the observations if one of them should be out of order. The SECCHI meteorograph is complete.

(4) Heliophotometer (CRAVERI), nefoscope (BRAUN), termoheliometer (MARY DEVY), pyroheliometer (PUILLET), photometer, cyanometer. ARAGO polarimeter, for direct atmospheric observations.

(*c*) *Magnetic division:*

(1) Declinometer, inclinometer, inclination balance for observing the variations in the intensity and direction of terrestrial magnetism. These apparatus are constructed according to the method of GAUSS.

(2) Inclination compass and magnetic theodolite (BRUNNER) for making exact observations of terrestrial magnetism.

(*d*) *Division of geodynamics and atmospheric electricity:*

(1) An instrument for microseismic observations.

(2) A ROSSI seismograph for observing the motions of earthquakes.

(3) A SECCHI seismograph for analyzing the motions of earthquakes.

(4) Galvanometer for the daily observations of the telluric current.

(5) PALMIERI electrometer with movable conductors; a BOENGHARTEN electroscope for making observations of the atmospheric electricity.

PEKIN, CHINA.

Observatory of the Imperial Russian Embassy.

Longitude from Greenwich, $7^h\ 45^m\ 56^s$ E.
Latitude, 39° 54′ 13″ N.
Authority for longitude and latitude: WURM, 1845. In Connaissance des Temps, 1884, p. xli.
Director: ——.

PISA, ITALY.

Observatorio.

Longitude from Greenwich, $41^m\ 36^s$ E.
Latitude, 43° 43′ 5″ N.
Authority for longitude and latitude: MARIENI, 1861. In Connaissance des Temps, 1884, p. xxxiv.
Director: ——.

PLONSK, RUSSIA.

Private Observatory of Dr. J. Jedrzejewicz.

Longitude from Greenwich, $1^h\ 21^m\ 32^s$ E.
Latitude, 52° 37′ 40″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale Observatoires et Astronomes, 1887.
Director: Dr. JEDRZEJEWICZ.

POLA, AUSTRIA.

Nautisches Observatorium.

Longitude from Greenwich, $55^m\ 23.18^s$ E.
Latitude, 44° 51′ 49″ N.
Directors: J. PALISA, 1872.
R. MÜLLER, 1880.
F. LASCHOBER.

Founded in 1872.

The observatory at Pola has grown out of the old marine observatory at Venice, which, after the campaign of 1848, was at first removed to Trieste, and from there to Pola in the year 1866. The observatory was naturally used chiefly as a "chronometer depot." That meteorological, and later magnetic observations were taken there was owing to the exertions of the director and to the sagacity of the leading marine central stations.

The regular meteorological records at Pola began in August, 1864, and were continued in the marine barracks by officers and cadets at an altitude of 20.5 meters till February 7, 1866, after which they were taken in charge by the marine observatory, which had just been moved here from Trieste.

The observatory has paid particular attention to astronomy only under Mr. J. PALISÁ'S direction. Mr. J. PALISA has discovered at this observatory twenty-three small planets, and his brother, Mr. A. PALISA, one comet. Since his call to Vienna nothing has been done in addition to the regular time determinations but to fix the position of occasional comets and small planets. We have at our disposal the following astronomical instruments:

One meridian, by TROUGHTON & SIMMS, with 6-inch object glass, of 6-foot focal distance, and two circles of 0.9 meter diameter.

One refractor, with 6-inch object glass, of 7-foot focal distance, objective by STEINHEIL.

One brachytelescope, by FRITSCH, Vienna, with 12-inch glass.

Two transportable comet-seekers.

Four fixed telescopes, by Messrs. FRAUNHOFER and PLÖSSEL.

Four pendulum clocks, among them a stationary pendulum, by KNOBLICH in Hamburg, as a normal clock.

One chronograph, by HIPP.

Several portable universal instruments and theodoliths.

It is intended to sell the brachytelescope, which was procured only to observe the last transit of Venus, and which has too little space in its cupola, and to install in its place the great comet-seeker in the way invented by VILLARCEAU. Beginning with the year 1885, the astronomical observations are to be taken up in a regular manner, and observations will be made particularly on the planets; later also the sun and the stars of 1° to 2° on the meridian circle; then on the refractor occasional observations of comets and planets; finally, with the small stationary telescope, the occultations of the stars and the eclipses of the satellites of Jupiter.

The building stands upon the highest hill within the town limits. The towers of the two parallactic mounted instruments are at the top of a second story. The meridian room is in a northern lateral wing. The executive offices and the chronometer depot occupy the northern half of the first floor. One messenger has lodgings in the building.

The observatory's endowment amounts to 3,200 Austrian florins annually, together with heating and lighting of all the rooms, incidentals, and the salaries of the officers and employés. This sum may be considered sufficient, although intended also for the completion and repair of the stock of chronometers.

PORT LOUIS, MAURITIUS.

Royal Alfred Observatory.

Longitude from Greenwich, $3^h\ 50^m\ 12.5^s$ E.
Latitude, 20° 5′ 39″ S.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Director: C. MELDRUM.

The foundation was laid by H. R. H. the Duke of Edinburgh, in May, 1870. Work commenced in 1874.

PORTSMOUTH, ENGLAND.

Observatory of the Royal Naval College.

Longitude from Greenwich, $4^m\ 24.8^s$ W.
Latitude, 50° 48′ 3″ N.
Authority for longitude and latitude: Connaissance des Temps, 1884, p. xiv.
Director: H. G. SWAINSON.

This establishment is no longer an astronomical observatory; its work being now confined to the testing of chronometers. The director is now "Superintendent of chronometers."

POTSDAM, PRUSSIA.

Astro-Physikalisches Observatorium.

Longitude from Greenwich, $52^m\ 15.9^s$ E.
Latitude, 52° 22′ 56″ N.
Director: Prof. Dr. H. C. VOGEL.

Built upon a hill adjoining the park at Potsdam. Opened in 1879 under the auspices of the Astronomische Gesellschaft, The new observatory erected by the Royal Government in the neighborhood of Potsdam, and whose buildings and equipments are now nearly completed, has for its fundamental purpose the investigation of the composition and movements of planetary bodies by means of spectral analyses and continued records of the events on their surfaces.

The observatory occupies the so-called Telegraphenberg, formerly a station of the optic telegraph line "Berlin–Cologne," situated south of the city of Potsdam, upon the east bank of the river Havel, and about 1½ kilometers (0.8013 mile) from the railroad depot. On the summit, 1^m 18^s W. of Berlin, in north latitude 52° 21′ 56″, 94 meters (318 feet) above the level of the sea and 64 meters (209 feet) above the level of the river Havel, is located the principal building, supplied with three movable cupolas, one of 10 and two of 7 meters (33 and 23 feet) diameter, respectively. Around this are physical, chemical, and photographic laboratories, workshops provided with a dynamo-electrical machine, office, janitor's dwelling, and some other rooms for observations and collections. Along the gentle northeast slope are three dwelling-houses for the scientific staff and the messenger; farther down, close to the entrance of the lot and 20 meters (65.6 feet) below the main building, lies the well, accessible for observations down to the level of the river Havel, the building of the water-works, a shop for the preparation of oil gas, and a dwelling-house for the machinists.

The observatory is surrounded by a tract of woods which forms a desirable protection against terrestrial radiation and at the same time serves as a condenser of atmospheric humidity.

This and the adjacent tract of land are the property of the Crown, and thus unobstructed possession for all times is secured for the observatory reservations, now amounting to nearly 17 hectares (42 acres).

The principal instrument of the observatory is a refractor of 0.298^m (11.7 inches) aperture and 5.4^m (17.7 feet) focus, made, together with auxiliary apparatus of spectroscopes and helioscopes, by H. SCHRÖDER, of Hamburg; parallactical mounting and micrometers by A. REPSOLD & SOHNE. It is used in plain astro-physical work, but principally for the observation of fixed stars, spectra of nebulæ, and for the study of planetary surfaces. Exclusively for solar observations it is proposed to use the second refractor, made by H. GRUBB, of Dublin, with a parallactic telescope of 0.207^m (8.1 inches) aperture and 3.4^m (11.1 feet) focus, and also a STEINHEIL telescope of 0.135^m (5.3 inches) aperture and 2.16^m (7 feet) focus, with parallactic mounting by PISTOR & MARTINS. This was formerly used by Professor SPORER, of Anclam, in his solar observations.

Furthermore, for regular photographic work of the sun a special heliograph is to be employed, of which now only exist the optical parts, made by H. SCHRÖDER, an achromatic objective of 0.16^m (6.3 inches) aperture and 4^m (13 feet) focus, together with ocular magnifying glasses, and of 0.25^m (9.8 inches) diameter.

The observatory furthermore owns some smaller telescopes, a 12-inch universal instrument by **Repsold**, a pendulum clock by **Kessels**, and one by **Knoblich**, box chronometers, one each, by **Kessels**, **Knoblich**, and **Irede**, and a considerable equipment of spectroscopic and other physical, chemical, and photographic apparatus, meteorological instruments, and a set of registering magnetic instruments after the **Kew** pattern.

Two observers were secured for its observatory on the 1st of July, 1874, namely: Prof. G. **Sporer**, formerly teacher of mathematics and physics, and pro-rector of the gymnasium in Anclam, and Prof. H. C. **Vogel**, formerly astronomer in the observatory of Kammerherr von Bülow, in Bothkamp; Dr. **Oscar Lohse**, of the same observatory, was engaged as first assistant. Professor **Sporer** continued in an intermistic building in Potsdam, the solar observations made in Anclam from 1861–1874, and Professor **Vogel** and Dr. **Lohse** observed at the Berlin Observatory until spring 1877, when temporary arrangements were made to enable them to observe in the new institute. Dr. **Gustav Müller** is employed as assistant since July 1, 1877, and Dr. **Paul Kempf** since July 1, 1878.

(Translated from, Publicationen des Astrophysikalischen Observatorium zu Potsdam. Erster Band. Mit sechszehn Tafeln. Potsdam, 1879.)

PUEBLA, MEXICO.

Observatory of the College of Jesus.

Longitude from Greenwich, $6^h\ 32^m\ 41^s$ W.
Latitude, 19° 2′ 30″ N.
Authority for longitude and latitude: A. **Lancaster**, Liste Générale des Observatoires et Astronomes, 1887, p. 49.
Director: P. **Spina**.

PULKOVA, RUSSIA.

Nicolaevskaia Glavnaia Observatoria.

Longitude from Greenwich, $2^h\ 1^m\ 18.67^s$ E.
Latitude, 59° 46′ 18.7″ N.
Directors: F. W. G. **von Struve**, 1834.
Otto von Struve, 1864.

Founded in 1834. Three principal halls on the ground floor, the eastern one being used for meridian circle; the western one for the meridian telescope, and the southern one occupied by the prime vertical. Three revolving domes, the central and largest containing **Merz** and **Mahler's** refractor, which has a focus of 23¼ feet (7.1^m), and an aperture of 15¼ inches (0.40^m). A very rich astronomical library. The most elaborate and minute researches on the minor corrections of spherical astronomy, notably the corrections of aberration of nutations and precession, have been made chiefly at this observatory.

PRAGUE, AUSTRIA.

I. *K. K. Universitäts Sternwarte.*

Longitude from Greenwich, 57^m 41.4^s E.
Latitude, 50° 5′ 18.8″ N.
Authority for latitude and longitude, AL. DAVID and J. BÖHM.
Directors: J. STEPLING, 1751.
A. STRANDT, 1781.
A. DAVID, 1799.
A. BITTNER, 1836.
K. KREIL, 1845.
C. JELINEK, 1851.
J. G. BÖHM, 1855.
Dr. C. HORNSTEIN, 1868.
Prof. LADISLANS WEINEK, ——.

TYCHO DE BRAHE had some astronomical instruments temporarily mounted at Prague (1600–1601). The observatory, properly so called, was not erected until 1751, in the Altstadt quarter, at the Collegium Clementinum, under the direction of the Jesuits.

INSTRUMENTS:

(*a*) *Meridian circle:* One; maker, CHR. STARKE (mechanical workshop of the I. R. Polytechnic Institute in Vienna); diameter of circle, 36 inches; divided to 3′; read by 4 nonius to 2″; aperture of objective, 4 inches.

(*b*) *Meridian transit instruments:* Maker, CHR. STARKE; aperture, 4 inches; (*b*′) maker, SCHRÖTTER; aperature of objective, 3 inches.

(*c*) *Equatorial instruments:* Makers, C. A. STEINHEIL'S SONS, in Munich; aperture of objective, 6 inches; magnifying powers of eye-pieces, 56, 84, 252, 420, 672. (*c*′) Makers, UTZSCHNEIDER & FRAUNHOFER, Munich; aperture of objective, 3 inches.

(*d*) *Spectroscopes:* One; G. & S. MERZ, Munich; one small star spectroscope; makers, G. & S. MERZ, Munich.

(*f*) *Chronograph:* One; Dr. M. HIPPS, Neuchatel, maker.

(*g*) *Clocks:* Mean time; makers, LEPAUTE, Paris; sidereal; makers, J. BOZEK, Prague.

(*h*) *Chronometer:* Mean time; maker, BARRAUD.

(*i*) *Miscellaneous:* One sextant; maker, TYCHO BRAHE; one octant; maker, TYCHO BRAHE; one large (Hohen Kreis), by TROUGHTON, in London.

II. *Sternewarte des Herrn A. Safarik.*

Longitude from Greenwich, 57^m 47^s E.
Latitude, 50° 4′ 25″ N..
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Director: A. SAFARIK.

PUY-LE-DOME, FRANCE.

Observatoire.

Longitude from Greenwich, 11m 33s E.
Latitude, 45° 46′ 28″ N.
Director: ——.

QUEBEC, CANADA.

Observatory.

Longitude from Greenwich, 4h 44m 49.3s W.
Latitude, 46° 48′ 17.3″ N.
Director: E. D. ASHE, 1863.
C. W. DRURY.

Prior to 1883 the instruments were at the residence of Capt. ASHE; they were then removed to the observatory at the citadel.

QUITO, ECUADOR.

Observatorio del Colegio Nacional.

Longitude from Greenwich, 5h 15m 20s W.
Latitude, 0° 14′ 0″ S.
Director: J. B. MENTEN, 1874.

RATHOWEN, IRELAND.

Obseratory of W. E. Wilson.

Longitude from Greenwich, ——.
Latitude, ——.
Director: W. E. WILSON.

RICHMOND (SURREY), ENGLAND.

Kew Observatory of the Royal Society.

Longitude from Greenwich, 1m 15.1s W.
Latitude, 51° 28′ 6″ N.
Directors: Sir FRANCIS RONALDS, 1842.
I. WELSH, 1852.
BALFOUR STEWART, 1859.
S. JEFFERYS, 1871.
G. M. WHIPPLE, 1876.

Erected in 1768 as the private observatory of George III; in 1841 it was dismantled and transferred to the British Association for use as a physical observatory; in 1871, having been endowed by J. P. GASSIOLT, esq., it was placed under the control of a committee of the Royal Society.

RIO DE JANEIRO, BRAZIL.

Imperial Nautical Observatory.

Longitude from Greenwich, 2ʰ 52ᵐ 41.41ˢ W.
Latitude, 22° 54′ 23.7″ S.
Directors: A. M. DE MELLS, 1850.
E. LIAIS, 1871.
L. CRULS.

Founded in 1780; restored in 1871.

ROME, ITALY.

I. *Osservatorio astronomico del Colegio Romano.*

Longitude from Greenwich, 49ᵐ 55.5ˢ E.
Latitude, 41° 53′ 53.7″ N.
Directors: G. ASCLEPI, 1764.
G. CALANDRELLI, 1773.
S. DUMOUCHEL, 1824.
F. DE VICO, 1838.
A. SECCHI, 1849.
G. S. FERRAR, 1878.
P. TACCHINI, 1879.

Before the establishment of a regular observatory a succession of astronomers, more or less famous, made use of temporary accommodations. In the buildings of the old college CLAVIAS made observations with a zenithal sector in 1572, and following years. SCHEINER collected the materials for his famous *Rosa Ursina*, the printing of which was completed in 1630 at the new college, west of the Church of St. Ignatius. There, too, GOTTIGNIES and BORGONDIO made occasional observations. MAIRE observed the comet of 1844 at the English college. BOSCOVICH fixed himself in the principal hall of the Kircher Museum. Finally, ASCLEPI organized a permanent establishment in 1764; and in 1787 a square tower was built to accommodate the observatory at the eastern angle of the college façade on via del Gesù. A new building was put up in 1853, having for substructure the enormous piles which had been intended to support the dome of the Church of St. Ignatius.

II. *Observatory of the Capitol.*

Longitude from Greenwich, 49ᵐ 56.5ˢ E.
Latitude, 41° 53′ 33.5″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Directors: G. CALLANDRELLI, 1824.
A. CONTI, 1827.
I. CALLANDRELLI, 1841.
L. RESPIGHI, 1876.

Established in 1824 upon the east tower of the capitol, which is built above the ancient forum.

III. Osservatorio astronomico privato.

Longitude from Greenwich, $49^m\ 50.3^s$ E.
Latitude, 41° 54′ 6″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Proprietor: Father S. FERRARI.

RUGBY, ENGLAND.

Temple Observatory.

Longitude from Greenwich, $5^m\ 1.9^s$ W.
Latitude, 52° 22′ 5″ N.
Curators: J. M. WILSON, 1872.
G. M. SEABROKE, 1878.

The observatory was built in 1871 as a memorial to Dr. TEMPLE, late head-master of Rugby School, now bishop of Exeter. The funds for this purpose were collected chiefly from old Rugbians by the Rev. J. M. WILSON.

RUNGSDORF (NEAR BONN), PRUSSIA.

Sternwarte.

Longitude from Greenwich, ———.
Latitude, ———.
Director: Baron CAMPHAUSEN.

SAINT CROIX, ANTILLES.

Observatoire.

Longitude from Greenwich, $4^h\ 18^m\ 43^s$ W.
Latitude, 17° 44′ 32″ N.
Authority for longitude and latitude: LANG. WURM, 1837. In Connaissance des Temps, 1884, p. lxii.
Director: ———.

ST. JOHN'S, NEW BRUNSWICK.

Observatory.

Longitude from Greenwich, ———.
Latitude, ———.
Director: ———.

SAIGON, FRENCH COCHIN CHINA.

Observatoire.

Longitude from Greenwich, 7h 6m 48s E.
Latitude, 10° 46′ 40″ N.
Authority for longitude and latitude: HATT, 1875. In Connaissance des Temps, 1884, p. xli.

ST. HELENA.

Observatory.

Longitude from Greenwich, 21m 9.98s W.
Latitude, 15° 55′ S.
Authority for longitude and latitude: Connaissance des Temps, 1884, p. lv.
Director: ———.

ST. PETERSBURG, RUSSIA.

I. *Observatoria Akademii Nauk* (*Observatory of the Imperial Academy of Sciences*).

Longitude from Greenwich, 2h 1m 13.5s E.
Latitude, 59° 56′ 29.7″ N.
Directors: J. N. DE L'ISLE, 1747.
P. INSCHODZOW, 1768.
R. BARRY, 1794.
V. WISNIWSKY, 1811.
A. SAWITSCH, 1856.

Founded in 1747.

II. *Astronomicheskaia Observatoria pri Imp. Universitet.*

Longitude from Greenwich, 2h 1m 11.4s E.
Latitude, 59° 56′ 32″ N.
Director: S. VON GLASENAPP.

III. *Zentralnaia Fisicheskaia Observatoria.*

Longitude from Greenwich, ———.
Latitude, ———.
Director: H. WILD.

SAN FERNANDO, SPAIN.

Instituto y Observatorio de Marina de San Fernando.

Longitude from Greenwich, 24m 49.6s W.
Latitude, 36° 27′ 41.5″ N.

Directors: R. **Armesto**, 1797.
J. O. **Canelas**, 1798.
J. T. **Cerguero**, 1825.
S. **Montojo**, 1851.
F. de P. **Marquez**, 1855.
C. **Pujazon**, 1866.

An observatory had first been established at Cadiz in 1753, upon an ancient Roman tower, but was soon abandoned, observations being made there only from 1773 to 1776 by **Tofiño** and **Varela**. The new observatory was built at San Fernando in 1797. This is the most southerly astronomical establishment in Europe.

SAN LUIS POTOSI, MEXICO.

Observatorio del Instituto Cientifica y Literaria.

Longitude from Greenwich, ———.
Latitude, ———.
Director: Dr. G. **Barroeta**.

SANTIAGO, CHILE.

Observatorio Nacional.

Longitude from Greenwich, $4^h\ 42^m\ 46.3^s$ W.
Latitude, 33° 26′ 42″ S.
Directors: E. G. **Moesta**, 1852.
J. I. **Vergara**, 1861.

Proposed in 1852. The instruments and buildings which had been used for the temporary Naval Observatory of the United States at Santa Lucia, under Lieutenant **Gilliss**, were purchased as a beginning, and in 1856 the construction of a permanent observatory was undertaken, consisting simply of a one-story building and central dome. The equipment has been added to gradually since 1859.

SCARBOROUGH, ENGLAND.

Observatory Wigglesworth.

Longitude from Greenwich, ———.
Latitude, ———.
Authority for longitude and latitude: A. **Lancaster**, Liste Générale des Observatoires et Astronomes, 1887.
Assistant: J. G. **Lohse**.

SCHWERIN, MECKLENBURG.

Geodetisches Observatorium.

Longitude from Greenwich, $45^m\ 40.7^s$ E.
Latitude, 53° 37′ 38.2″ N.
Authority for longitude and latitude: Astron. Nachr., LVII, 6, 1868.
In Connaissance des Temps, 1884, p. xxviii.

SENFTENBERG, BOHEMIA.

Sternwarte des Baron Perish.

Longitude from Greenwich, $1^h\ 5^m\ 50.6^s$ E.
Latitude, 50° 5′ 10.4″ N.
Director: Dr. Boorsen.
Ceased to exist.

SLOUGH, ENGLAND.

Observatory.

Longitude from Greenwich, $2^m\ 23^s$ W.
Latitude, 51° 30′ 20″ N.
Authority for longitude and latitude: Connaissance des Temps, 1884, p. xvi.
Director: ——.

SOUTH KILWORTH, ENGLAND.

Observatory.

Longitude from Greenwich, $4^m\ 26^s$ W.
Latitude, 52° 25′ 51″ N.
Authority for longitude and latitude: Connaissance des Temps, 1884, p. xvi.

SPEYER, BAVARIA.

Sternwarte des Königlichen Lyceums.

Longitude from Greenwich, $33^m\ 45.6^s$ E.
Latitude, 49° 18′ 55.4″ N.
No longer in existence.

STARFIELD, ENGLAND.

Observatory.

Longitude from Greenwich, $11^m\ 47^s$ W.
Latitude, 53° 25′ 3″ N.
Authority for longitude and latitude: Connaissance des Temps., 1884, p. xvi.

STOCKHOLM, SWEDEN.

Observatory.

Longitude from Greenwich, $1^h\ 12^m\ 14^s$ E.
Latitude, 59° 20′ 34″ N.
Directors: P. V. Wargentin, 1750.
H. Nicander, 1776.
J. Svanberg, 1803.
S. A. Cronstrand, 1828.
N. H. Selander, 1858.
J. A. Hugo Gylden, 1871.

Founded in 1750. Here WARGENTIN made that long series of observation on Jupiter's satellites which resulted in the first reliable tables of eclipses of these satellites.

INSTRUMENTS:

(*a*) *Meridian circle:* Makers, ERTEL & SON; diameter of circles, 18 inches; divided to 3′; read by 4 microscopes to 1″; aperture of objective, 4¼ inches (0.107 meters); magnifying power ordinarily employed, 124 diameters.

(*b*) *Meridian transit instrument:* Maker, A. REPSOLD; aperture, 2½ inches.

(*c*) *Equatorial instrument:* Maker, A. REPSOLD; aperture of objective, 7 inches; magnifying powers of eye-pieces, 114, 150, 190, 302, 600.

(*f*) *Chronographs:* Two.

(*g*) *Clocks:* Mean time; makers, MOLYNEUX & COPE; sidereal; makers, KESSELS, SWEDER.

(*h*) *Chronometer:* Mean time; makers, DENT, LINDEROTH.

STONYHURST COLLEGE (NEAR WHALLEY), ENGLAND.

Stonyhurst College Observatory.

Longitude from Greenwich, 9ᵐ 52.68ˢ W.
Latitude, 53° 56′ 40″ N.
Authority for longitude and latitude: Nautical Almanac.
Directors: Rev. A. WELD, S. J., F. R. A. S., 1838.
Rev. S. J. PERRY, S. J., F. R. A. S., 1860.

Location: Four miles W. of Whalley, Lancashire, England.

Height above sea, 381 feet. Built in 1838 in the park of the Jesuit College.

INSTRUMENTS:

(*a*) *Meridian circle:* By Jones; 2 feet 6 inches; divided to 5′; microscopes reading to 1″; aperture of object glass, 3 inches; power generally used, 56.

(*b*) *Transit instrument:* Aperture of object glass, 2⅝ inches; power generally used, 42; by CARY.

(*c*) *Equatorial instruments*: One by NAPIER, CURRY, TROUGHTON and SIMMS; aperture, 8 inches; powers from 30 to 600 or 700; one by JONES; aperture, 4 inches. (*c′*) A CASSEGRAIN reflector; aperture, 9¼ inches; two, NEWTONIAN; aperture, 7 inches.

(*d*) *Spectroscopes:* An automatic instrument by BROWNING, 6 prisms of 60°, each used twice, with a half prism, making largest dispersion=36 prisms of 60°. A large star spectroscope by SIMMS, 4 compound prisms by HOFFMAN. A large direct-vision spectroscope by BROWNING. Two smaller instruments by BROWNING.

(*f*) *Chronograph:* Small one by BREGUET.

(*g*) *Clocks:* Two sidereal, mercurial pendulums.

(*h*) ***Chronometer:*** FRODSHAM, No. 3148.

(*i*) ***Miscellaneous:*** A couple of self-recording meteorological and magnetical instruments are in constant use.

STRASBURG, GERMANY.

Sternwarte.

Longitude from Greenwich, $31^{m}\ 2.49^{s}$ E. Latitude, 48° 34′ 53.8″ N.	Of the old observatory.
Longitude from Greenwich, $31^{m}\ 4.65^{s}$ E. Latitude, 48° 34′ 59.7″ N.	Of the new observatory.

Director: A. WINNECKE.

About 1770 some astronomical instruments were placed above the gate of the hospital. In 1804 J. HENRY established a small observatory in the Münster (Cathedral) and observations were made there in 1824. A regular observatory was not established by the city until 1836, and then it was placed under the charge of LEQUIANTE, but almost immediately abandoned. In 1873 a new observatory was erected without the town, in connection with the University. Its general plan is a quadrilateral.

SYDNEY, NEW SOUTH WALES, AUSTRALIA.

Government Observatory.

Longitude from Greenwich, $10^{h}\ 4^{m}\ 50.6^{s}$ E.
Latitude, 33° 51′ 41.1″ S.
Directors: W. SCOTT, 1856.
G. R. SMALLEY, 1862.
H. C. RUSSELL, 1870.

Proposed in 1855; completed in 1858. Its first instruments, supplied from the private observatory which BRISBANE had established at Paramatta, were those by means of which DUNLAP had made his catalogues of double stars and of southern nebulæ.

TACUBAYA, MEXICO.

Observatorio Astronomico Nacional Mexicano.

Longitude from Greenwich, $6^{h}\ 36^{m}\ 41.63^{s}$ W.
Latitude, 19° 24′ 17.5″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Director: ANGEL ANGUIANO.

Projected in 1876, and established at Chapultepec in 1878. Transferred from Chapultepec March 8, 1883.

TACHKENT, RUSSIA.

Observatoire Astronomique et Physique de Tachkent.

Longitude from Greenwich, 4h 37m 10.8s E.
Latitude, 41° 19′ 32.2″ N.
Authority for longitude, telegraphic; for latitude, vertical circle observations.
Director: H. POMERANZEFF, 1880.

TIFLIS, RUSSIA.

Observatoria.

Longitude from Greenwich, 2h 59m 17s E.
Latitude, 41° 41′ 46″ N.
Authority for longitude and latitude: Triangulation, Novo Tcherkask, 1862. In Connaissance des Temps, 1884, p. xlii.

TOKIO, JAPAN.

Observatory of the Daigaku.

Longitude from Greenwich, ——.
Latitude, ——.
Director; Prof. H. M. PAUL.

TOULON, FRANCE.

Observatoire de la Marine.

Longitude from Greenwich, 23m 42s E.
Latitude, 43° 7′ 22″ N.
Authority for latitude and longitude: Connaissance des Temps, 1884, p. xii.
Director: —— PAGEL.

TOULOUSE, FRANCE.

Observatoire de Toulouse.

Longitude from Greenwich, 5m 51.1s E.
Latitude, 43° 36′ 45.3″ N.
Directors: F. P. A. DE GARIPNY, 1735.
A. DARQUIER DE PELLEPOIX, 1748.
J. VIDAL, 1774.
DUBUISSON, 1807.
VICTOR DE MARQUÉ, 1822.
DE DESPLATS ET VAUTHIER, 1832.
E. PETIT, 1867.
—— DESPEYROUS, 1867.
SAGUIN, 1867.
F. DE TISSERAND, 1873.
B. BAILLAUD, 1878.

TREVANDRUM, INDIA.

His Highness the Maha Rajah's Observatory.

Longitude from Greenwich, 5h 7m 59s E.
Latitude, 80° 30′ 32″ N.
Directors: JOHN CALDECOTT, F. R. A. S., 1837.
JOHN ALLAN BRONN, F. R. S., 1852.

TRIESTE, AUSTRIA.

Astronomisches und Meteorologisches Observatorium der K. K. Nautischen und Handels Akademie.

Longitude from Greenwich, 55m 2.1s E.
Latitude, 45° 38′ 34″ N.
Directors: F. SCHAUB, 1857.
A. KUNES, 1870.
A. PALISA.

TUNBRIDGE WELLS, ENGLAND. (See CROWBOROUGH.)

TURIN, ITALY.

Regio Osservatorio dell' Universita.

Longitude from Greenwich, 30m 48.4s E.
Latitude, 45° 4′ 6″ N.
Directors: G. B. BECCARIA, 1759.
T. VALPERGADI CALUSO, 1782.
A. M. VASSALI EANDI, 1806.
J. PLANA, 1811.
A. DORNA, 1865.

Established in 1759 in the top of a tower at the corner of Piazza Castello. The Academy of Sciences undertook its direction in 1790, and had a new observatory built in the palace of the academy. In 1820 the establishment was transferred to a terrace of the Palazzo Madama. In 1865 the observatory became an appendage of the university.

TWICKENHAM, ENGLAND.

Longitude from Greenwich, 1m 13.1s W.
Latitude, 51° 27′ 4.2″ N.
Director: Mr. HIND.

UCKFIELD, ENGLAND.

Observatory of Captain W. Noble.

Longitude from Greenwich, 17.8s E.
Latitude, 51° 0′ 56.3″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Proprietor: W. Noble.

UPSALA, SWEDEN.

Observatory of the University.

Longitude from Greenwich, 1h 10m 30s E. } Of the old observatory.
Latitude, 59° 51′ 37″ N. }
Longitude from Greenwich, 1h 10m 30s E. } Of the new observatory.
Latitude, 59° 51′ 29.4″. }
Authority for longitude and latitude: New determination in 1880–'81, by C. BOHLIN.
Directors: A. CELSIUS, 1730.
M. STRÖMER, 1745.
D. MELANDERHJELM, 1761.
E. PROSPERIN, 1797.
L. REGNÈR, 1799.
J. BREDMAN, 1811.
G. SVANBERG, 1842.
HERMAN SCHULTZ, 1864.

This observatory was founded in 1742, and ceased to exist in 1853. The new observatory was founded in 1844 by G. SVANBERG, finished and in use since 1853.

URBINO, ITALY.

Osservatorio del Colegio Rafaël.

Longitude from Greenwich, 50m 33.1s E.
Latitude, 43° 43′ 29.59″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Director: G. MARTINOTTI.

UTRECHT, HOLLAND.

Observatorium.

Longitude from Greenwich, 20m 31.7s E.
Latitude, 52° 5′ 9.5″ N.
Directors: J. F. HEUNERT, 1767.
G. MALL, 1812.
R. VAN REES, 1836.
M. HOCK, 1860.
J. A. C. OUDEMANS, 1874.

Founded in 1767. Remodelled in 1864.

VALENTIA, IRELAND.

Observatory of the London Meteorological Office.

Longitude from Greenwich, 41m 16s W.
Latitude, 51° 54′ 36″ N.

Directors: Rev. T. KERR, 1868.
J. E. CULLUM, 1875.

Established by the London Meteorological Office in 1868 as an observatory of the first order.

VENICE, ITALY.

Observatory of the Naval Institute.

Longitude from Greenwich, 49m 22.12s E.
Latitude, 45° 26′ 8.5″ N.
Directors: B. VON WÜLLERSDORF-URBAIR, 1840.
E. MILLOSEVICH, 1874.

Established about 1840.

VERONA, ITALY.

Osservatorio.

Longitude from Greenwich, 43m 56s E.
Latitude, 45° 26′ 8″ N.
Authority for longitude and latitude: Ingén. géogr. 1837. In Connaissance des Temps, 1884, p. xxxv.
Director: ——.

VIENNA, AUSTRIA. (See WIEN.)

VILNA, RUSSIA.

Astronomicheskaia Observatoria.

Longitude from Greenwich, 1h 41m 11.9s E.
Latitude, 54° 41′ N.
Authority for longitude and latitude: SLAVINSKI: "Astronomische Nachrichben," Vols. V and VIII.
Directors: M. O. POCZOBUT, 1764.
J. B. VON SNIADECKI, 1808.
P. SLAVINSKI, 1824.
M. KLOUSCHNEVITCH, 1841.
G. A. VON FUSS, 1848.
G. SABLER, 1854.
Col. PETER SMYSLOFF, 1867.

It appears that this observatory had already existed for some time when in 1764 POCZOBUT restored it and replaced its instruments. Its labors, suspended during the revolution, were not resumed until 1802.

INSTRUMENTS:

(*b*) *Meridian transit instrument:* Maker, RAMSDEN, in 1777; aperture, 4 inches; magnifying power 40 diameters.

(*c*) *Equatorial instrument:* Maker, RAMSDEN, in 1777; aperture of objective, 4 inches; magnifying powers of eye-pieces, 40 and 60.

(*d*) *Spectroscope:* Direct vision, maker, S. MERZ, at Munich.

(*e*) *Photometer:* Made by the late Prof. L. SCHWERD, at Speyer. Of the three made by him, one is in Bonn, and the other in Pulkowa.

(*f*) *Chronograph:* Maker, ANSFELD, at Gotha.

(*g*) *Clocks:* One, mean time, maker, SHELTON (London); one sidereal, maker, HARDY (London 1819).

(*h*) *Chronometer:* One, mean time, maker, DENT, No. 2,796; one sidereal, maker, DENT, No. 2,000.

(*i*) A heliostat, by S. MERZ. Various ancient astronomical instruments and modern meteorological instruments. The library of the observatory contains 1,966 works, in 4,181 volumes.

VIVIERS, FRANCE.

Observatoire.

Longitude from Greenwich, $18^m\ 44^s$ E.
Latitude, 44° 29′ 14″ N.
Authority for longitude and latitude: Connaissance des Temps, 1884, p. xii.
Director: ——.

WARSAW, RUSSIA.

Astronomicheskaia Observatoria.

Longitude from Greenwich, $1^h\ 24^m\ 7.4^s$ E.
Latitude, 52° 13′ 5.7″ N.
Directors: —— ARININSKI, 1820.
J. D. BARANOWSKI, 1848.
J. WOSTOKOFF, 1877.

In 1764 Rostan made observations at the castle. From 1765 to 1768 N. WOLF made observations at the Blue Palace on the Mniszech. The observatory was not established permanently until 1820, and the expenses of construction were met by STRASZYZ, president of the university. It contains a hall for meridian instruments, and two towers with cupolas.

WELLINGTON, NEW ZEALAND.

Government Observatory.

Longitude from Greenwich, $11^h\ 39^m\ 11^s$ E.
Latitude, 41° 17′ 15″ S.
Authority for longitude and latitude: Connaissance des Temps, 1884, p. lii.
Director: ——.

WHALLEY, ENGLAND. (See STONYHURST.)

WIEN, AUSTRIA.

I. *K. K. Universitäts Sternwarte in Währing.*

Longitude from Greenwich, $1^h\ 5^m\ 21.49^s$ E.
Latitude, 48° 13′ 55.4″ N.
Directors: M. HELL, 1756.
F. VON FRIESNECKER, 1792.
J. S. BÜRG, 1817.
J. J. VON LITTROW, 1819.
K. L. VON LITTROW, 1841.
D. EDMUND WEISS.

The first observations made in Vienna were undertaken in 1745 by the Jesuits J. FRANÇOIS and J. LIESGANG. A permanent observatory was founded in 1756. It was rebuilt from 1820 to 1826, and located among the university buildings. In 1874 a new establishment on a greatly enlarged scale was erected at Währing, outside the town, and completed in 1879.

INSTRUMENTS:

(*a*) *Meridian circle:* Made by CHRISTIAN STARKE, at Vienna (after the example of the meridian circles of REICHENBACH); diameter of circles, 36 inches; divided to 3′; read by four microscopes to single seconds; aperture of objective, 48 inches; magnifying power ordinarily employed 120 diameters.

(*b*′) *Prime vertical:* Maker, CHRISTIAN STARKE; aperture, 50 inches; magnifying power, 120 diameters.

(*c*) *Equatorial instruments:* One, made by ALVAN CLARK & SONS; aperture of objective, 11¾ inches; magnifying powers of eye-pieces, up to 1,200. (*c*′) One, made by FRAUENHOFER; aperture of objective, 6 inches; magnifying powers, up to 600.

(*d*) *Spectroscopes:* One small star spectroscope; one ZOELLNER'S solar spectroscope.

(*g*) *Clocks:* Two mean time; makers, UTZSCHNEIDER, at Munich; VORAUER, at Vienna; several sidereal; makers, MOLYNEUX (London); AUCH (Gotha); GRAHAM (London); and a few, more or less accurate.

(*h*) *Chronometers:* Mean time; maker, ARNOLD; sidereal, makers, KESSELS, MOLYNEUX.

(*i*) *Miscellaneous:* An equatorial with adaptation for various latitudes, the 6-inch objective by STEINHEIL, the mounting by SCHÄFFLER. Two refractors of 4-inch aperture; one of them not equatorially mounted. One equatorial of 3-inch aperture, adapted for various latitudes, objectives by FRAUENHOFER. One equatorial of 3-inch aperture, by DOLLOND. One dialitic equatorial of PLÖSSEL, of 5 inches. One comet-seeker, of 6-inch aperture and 4 feet focal length, by MERZ; mounted equatorially on the principle of VILLAREAU, by SCHNEIDER. One comet-seeker of 3-inch aperture by PLÖSSEL; one of 2½ inches, by STEINHEIL. Besides these, various smaller portable transit instruments, theodolites, sextants, etc.

II. *Observatory of the High School of Technology.*

Longitude from Greenwich, $1^h\ 5^m\ 25.3^s$ E.
Latitude, 48° 12′ 53.8″ N.
Directors: J. HERR, 1865.
W. SINTER, 1870.

Founded in 1865 at the southwestern extremity of the city; completed in 1867.

III. *Private Observatory.*

Longitude from Greenwich, $1^h\ 5^m\ 25.3^s$ E.
Latitude, 48° 12′ 54.9″ N.
Director: Dr. TH. VON OPPOLZER.

IV. *Hohe Warte (bei Döbeln).*

Longitude from Greenwich, ———.
Latitude, ———.
Director: Dr. JULIUS HAUN.

V. *Sternwarte Kuffner.*

Longitude from Greenwich, $1^h\ 5^m\ 11^s$ E.
Latitude, 48° 12′ 47.8″ N.
Authority, A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Director: Dr. N. HERZ.

VI. *Sternwarte des Herrn K. Fritsch.*

Longitude from Greenwich, ———.
Latitude, ———.
Director: K. FRITSCH.

VII. *Sternwarte des Herrn Baron A. von Rothschild.*

Longitude from Greenwich, ———.
Latitude, ———.
Director: ———.

VIII. *Sternwarte des Herrn W. Biela.*

Longitude from Greenwich, ———.
Latitude, ———.
Director: W. BIELA.

IX. *Sternwarte des Herrn L. Kurzmayer.*

Longitude from Greenwich, ———.
Latitude, ———.
Director: L. KURZMAYER.

WILLIAMSTOWN, VICTORIA.

Observatory.

Longitude from Greenwich, $9^h\ 39^m\ 38.8^s$ E.
Latitude, 37° 52′ 7.2″ S.
Removed to Melbourne, Victoria, in 1861.

WILHELMSHAVEN, GERMANY.

Kaiserliches Marine Observatorium.

Longitude from Greenwich, $32^m\ 35.21^s$ E.
Latitude, 53° 31′ 52.2″ N.
Authority for longitude: Astronomische Arbeiten des Kgl. preuss. Geodätischen Instituts für 1878; for latitude: Director's observations of zenith-stars with meridian circle.
Director: C. BÖRGEN, Dr. Phil., 1876.
Founded in 1875; completed in 1878.

INSTRUMENTS:

(*a*) *Meridian circle:* One; makers, A. REPSOLD SÖHNE, in Hamburg; diameter of circles, 21.6 inches, divided to 2′; read by 4 microscopes, each to 0.1″; aperture of objective, 4½ inches; magnifying power ordinarily employed, 125 diameters.

(*b*) *Meridian transit instruments:* One portable, by C. BAMBERG, Berlin; aperture, 1½ inches.

(*c*) *Equatorial instruments:* One, by STEINHEIL SÖHNE, in Munich; aperture of objective, 4 inches; magnifying powers of eye-pieces, 48 to 360; ring-micrometer. (*c′*) One, STEINHEIL SÖHNE; 2½ inches aperture; magnifying power, 24 to 150.

(*f*) *Chronograph:* One, by FUESS, Berlin.

(*g*) *Clocks:* Mean time; one, by EPPNER, Berlin; sidereal; one, by F. TIEDE, Berlin (standard clock).

(*i*) *Miscellaneous:* A complete set of LAMONT's instruments for observing the variations of the magnetical declination, horizontal force, and inclination.

LAMONT's magnetical theodolite; dip-circle by DOVER; self-registering barometer and anemometer (ROBINSON); meteorological instruments; self-registering tide-gauge; time-ball. Since September, 1880, a self-registering tide-gauge, devised by Mr. REITZ, of Hamburg, has been erected in Heligoland and placed under the control of this observatory.

WINDSOR, NEW SOUTH WALES, AUSTRALIA.

Observatory of John Tebbut.

Longitude from Greenwich, $10^h\ 3^m\ 21.8^s$ E.
Latitude, 33° 36′ 28.8″ S.
Director: JOHN TEBBUT.

WOLSINGHAM, ENGLAND.

Observatory of the Liverpool Astronomical Society.

Longitude from Greenwich, ——.
Latitude, ——.
Authority: A. LANCASTER, Liste Générale, etc., 1887, p. 63.
Observer: T. E. ESPIN.

ZACATECAS, MEXICO.

Observatory.

Longitude from Greenwich, $6^h\ 41^m\ 0.67^s$ W.
Latitude, 22° 46′ 34.9″ N.
Authority for longitude and latitude: A. LANCASTER, Liste Générale des Observatoires et Astronomes, 1887.
Director: A. JOSE Y BONILLA.

ZIKAWEI, CHINA.

Longitude from Greenwich, ——.
Latitude, ——.
Director: MARC DECHEVREUS.

ZÜRICH, SWITZERLAND.

I. *Sternwarte des Schweizerischen Polytechnikums.*

Longitude from Greenwich, $31^m\ 12.6^s$ E.
Latitude, 47° 22′ 40″ N.
Authority for longitude and latitude: Astronomische Mittheilungen von Dr. RUDOLF WOLF.
Directors: J. H. WASER, 1773.
J. FEER, 1787.
J. ESCHMANN, 1823.
RUDOLF WOLF, 1860.

Founded in 1773 upon the Carolus Thurm (Charles Tower), through the efforts of the Zürich Society of Naturalists. Abandoned from 1798 to 1805. In 1810 a new observatory was erected east of the Carolus Thurm; this was abandoned in 1852. Finally in 1860 the observatory was rebuilt at the polytechnikum, where it was inaugurated in 1863.

The observatory is mainly used for the practical training of the students. The scientific results are voluntary contributions by the director and assistant.

INSTRUMENTS:

(*a*) *Meridian circles:* Two; makers, KERN, in Aarau, ERTEL, in Munich; diameter of circles, 20 inches; divided to 2′; read by 2 microscopes to 0.1″; aperture of objective, 5.3 inches; magnifying power ordinarily employed, 120.80.

(*e*) *Equatorial instruments:* Makers, **Kern**, in Aarau; aperture of objective, 6 inches; magnifying power of eye-pieces, 60 to 500. (*c*′) **Merz**, in Munich, 3½ inches; 64 to 212.

(*d*) *Spectroscope:* One, by **Merz**, in Munich.

(*f*) *Chronographs:* Four, by **Hipp**, in Neuchatel, and **Hassler**, in Aarau.

(*g*) *Clocks:* Mean time; makers, Association ouvrière au Locle; sidereal; maker, **Silvain Mairet**, Locle. Also several pendulum clocks, among which one by **Repsold**.

(*h*) *Chronometer:* Sidereal; seconds chronometer; maker, **Buzengeiger**.

(*i*) *Miscellaneous:* Several astronomical theodolites, meteoroscopes, panagenprisms, etc.; also historical collection of antique instruments.

II. *Private Observatory.*

Longitude from Greenwich, ———.
Latitude, ———.
Director: Dr. F. **Schinz**.

no. 5

SMITHSONIAN MISCELLANEOUS COLLECTIONS.

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L.O. from E.S.H.

BIBLIOGRAPHY

OF

ASTRONOMY:

FOR THE YEAR

1887

BY

WILLIAM C. WINLOCK,

ASSISTANT ASTRONOMER, UNITED STATES NAVAL OBSERVATORY.

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BIBLIOGRAPHY OF ASTRONOMY: 1887.

BY WILLIAM C. WINLOCK.

The following subject-index of astronomy for 1887 was originally compiled as an appendix to a general review of the progress of astronomy during that year, and though not exhaustive, it may, perhaps, be found a useful reference list. Important contributions to astronomy published during 1887 in scientific journals and transactions of societies, as well as all more elaborate publications that have come to the compiler's notice, have been included—a few titles being taken from reviews, or book-catalogues. Observations of asteroids and comets, except those of the comets of 1887, have generally been omitted.

The prices quoted are usually from Friedländer's *Naturæ Novitates*, in German "marks" (1 Mark = 100 Pfennige = 1 franc 25 centimes = 25 cents, nearly.)

The abbreviated titles will probably be readily understood by those familiar with scientific periodicals without special explanation, beyond the following list of less obvious contractions.

Abstr. = Abstract.
Am. = American.
Bd. = Band.
d. = die, der, del, etc.
ed. = edition.
Hft. = Heft.
hrsg. = herausgegeben.
il. = illustrated.
j., jour. = journal.
k. k. = kaiserlich königlich.

Lfg. = Lieferung.
M. = marks.
n. d. = no date.
n. p. = no page.
n. F. = neue Folge.
n. s. = new series.
not. = notices.
obsns. = observations.
Obsry. = Observatory.
p. = page.
pl. = plates.

pt. = part.
r. = reale.
Rev. = review.
s. = series.
sc. = science, scientific.
sh. = shilling,
sup. = supplement.
v., vol. = volume.

In the references to journal articles the volume and page are simply separated by a colon, thus: "Bull. astron., 4: 94–98," indicates volume 4, pages 94 to 98.

Aberration.

Michelson (A. A.) & Morley (E. W.) Relative motion of the earth and the luminiferous æther. il. Am. j. sc., 134: 333–345.

Thewis (—.) Sur la théorie de l'aberration de M. Seeliger. Bull. astron., 4: 94–98.

Aberration (Constant of).

Comstock (G. C.) New mode of determining the constants of refraction and aberration. Sid. mess., 6: 310–317. (Abstract of Loewy's method.)

—— Note on the determination of the constant of aberration. Astron. jour., 7: 157.

Armagh observatory.

DREYER (J. L. E.) Electric illumination of the Armagh refractor. Month. not., 47: 117.

[Report for 1886.] *Ibid.*, 151.

Asteroid 5.

GALLE (A.) Über die im September, 1888, stattfindende Annäherung der Planeten (5) Astraea und (8) Flora. Astron. Nachr., 118: 78.

Asteroid 17.

CHARLIER (C. V. L.) Untersuchung über die allgemeinen Jupiter-Störungen des Planeten Thetis. 98 p. 4to.

Kongl. svenska Vetens-Akad. handl. 22, no. 2.

Asteroid 69.

[KREUTZ (H.)] Neuer Planet Luther vermuthlich identisch mit (69) Hesperia. Astron. Nachr., 116: 335, 365.

Detected by Luther 1887, Apr. 11, and by Coggia 1887, Apr. 16, and announced as a new asteroid.

Asteroid 80.

ROBERTS (I.) Photographic search for the minor planet Sappho. Month. not., 47: 265.

Asteroid 181.

DE BALL (L.) Recherches sur l'orbit de la planète (181) Eucharis. 44 p. 4to. Bruxelles, 1887. (M. 2.50.)

Asteroid 240.

SAINT-BLANCAT (D.) [Elements from observations 1884–1886.] Bull. astron., 4: 198.

Asteroid 264.

MILLOSEVICH (E.) [Elements from normals 1886, Dec. 20; 1887, Jan. 22, and observation of Feb. 24.] Atti d. r. accad. d. Lincei, s. 4, Rend., 3: 476–480.

Asteroid 265. Anna.

Discovered by J. Palisa at Vienna, 1887, Feb. 25. Circ. Berl. astron. Jahrb., 292. *Also:* Astron. Nachr., 116: 223.

KNOPF (O.) [Elements from obsns. 1887, Feb. 25, Mar. 25, Apr. 17.] Circ. Berl. astron. Jahrb., 296.

LANGE (H.) [Elements from obsns. 1887, Feb. 25, Mar. 11, 25.] *Ibid.*, 294.

MILLOSEVICH (E.) Sul pianetino (265). Atti d. r. accad. d. Lincei, s. 4, Rend., 3: 266.

Asteroid 266. Aline.

Discovered by J. Palisa at Vienna, 1887, May 17. Circ. Berl. astron. Jahrb., 298. *Also:* Astron. Nachr., 117: 47.

LANGE (H.) [Elements from obsns. 1887, May 17, 29, June 11.] Circ. Berl. astron. Jahrb., 299.

Asteroid 267. Tirza.

Discovered by A. Charlois at Nice, 1887, May 27. Circ. Berl. astron. Jahrb., 298. *Also:* Astron. Nachr., 117: 63. *Also:* Bull. astron., 4: 260.

Asteroid 267. Tirza—*Continued.*

Charlois (A.) [Elements from obsns. 1887, May 27, June 9, 22.] Circ. Berl. astron. Jahrb., 301. *Also:* Compt. Rend., 105: 53.

——— [Elements from obsns. 1887, May 27, June 25, July 23.] Circ. Berl. astron. Jahrb., 308.

Asteroid 268. Adorea.

Discovered by A. Borrelly at Marseilles, 1887, June 9. Circ. Berl. astron. Jahrb., 299. *Also:* Astron. Nachr., 117: 103.

Lange (H.) [Elements from obsns. 1887, June 9, 23, July 13.] Circ. Berl. astron. Jahrb., 301.

Asteroid 269.

Discovered by J. Palisa at Vienna, 1887, Sept. 21. Circ. Berl. astron. Jahrb., 305. *Also:* Astron. Nachr., 117: 359.

Berberich (A.) [Elements from normals 1887, Sept. 23, Oct. 13, and observation Nov. 12.] Circ. Berl. astron. Jahrb., 308.

Asteroid 270. Anahita.

Discovered by C. H. F. Peters at Clinton, 1887, Oct. 8. Circ. Berl. astron. Jahrb., 306. *Also:* Astron. Nachr., 117: 15.

Lange (H.) [Elements from obsns. 1887, Oct. 11, 26, Nov. 13.] Circ. Berl. astron. Jahrb., 308.

Viennet (E.) [Elements from obsns. 1887, Oct. 11, 18, 26.] Compt. Rend., 105: 1002.

——— [Elements from normals 1887, Oct. 12, 27, Nov. 16.] *Ibid.*, 1234.

Asteroid 271. Penthesilea.

Discovered by V. Knorre at Berlin, 1887, Oct. 13. Circ. Berl. astron. Jahrb., 306. *Also:* Astron. Nachr., 118: 31.

Knopf (O.) [Elements from obsns. 1887, Oct. 13, 25, Nov. 13.] Circ. Berl. astron. Jahrb., 308.

Asteroids.

[Asteroids discovered in 1886.] Month. not., 47: 172. *Also:* Bull. astron., 4: 15.

Glauser (—.) Lage der Asteroiden-Bahnebenen. Astron. Nachr., 117: 153-162.

Kirkwood (D.) The asteroids or minor planets between Mars and Jupiter. 60 p. 12mo. Philadelphia, 1887. ($0.75.)

——— Distribution of the minor planets. Sid. mess., 6: 116.

——— Eccentricities and inclinations of the asteroidal orbits. *Ibid.*, 169.

Lehmann (P.) Zusammenstellung der Planeten-Entdeckungen im Jahre 1886. Vrtljschr. d. astron. Gesellsch., 22: 9-14.

Parkhurst (H. M.) Photometric observations of asteroids. Sid. mess., 6: 353.

Astronomische Gesellschaft.

Bericht über die Versammlung . . . zu Kiel, 1887, Aug. 29 bis 31. Vrtljschr. d. astron. Gesellsch., 22: 264-284.

Astronomische Gesellschaft—*Continued.*

Berichte über die Beobachtung der Sterne bis zur neunten Grösse am nördlichen Himmel. *Ibid.*, 350–358.

Berichte betreffend die Vorbereitungen der Zonen-Beobachtungen zwischen —2° und —23° 10′. *Ibid.*, 358–361.

Krüger (A.) Zwölfte Versammlung der astronomischen Gesellschaft . . . Kiel, 1887, Aug. 29–31. Astron. Nachr., 117: 199, 297–306, 391. *See, also, Ibid.*, 116: 383. *Also:* Obsry., 10: 337–339.

[Report of Kiel meeting, 1887, Aug. 29–31.] Obsry., 10: 337–339.

Vierteljahrsschrift der astronomischen Gesellschaft. Hrsg. von E. Schoenfeld und H. Seeliger 22. Jahrg., 1887. 417 p., pl., por. 8vo. Leipzig, 1887. (M. 8.)

Astronomy.

McFarland (R. W.) Astronomy and the ice-age. Sid. mess., 6: 117.

Monk (W. H. S.) Astronomy and the ice-age. *Ibid.*, 57, 194.

Astronomy (Bibliography of).

Houzeau (J. C.) & Lancaster (A.) Bibliographie générale de l'astronomie. Tome premier. Ouvrages imprimés et manuscrits. Première partie. 7 + 858 p. 4to. Bruxelles, 1887. (M. 25.)

Rev. by Houzeau (J. C.) & Lancaster (A.), Ciel et terre, 8: 153–161, 187–193; Faye (H.), Compt. Rend., 105: 923; Liagre (J.), Ciel et terre, 8: 321; Maunder (E. W.), Obsry., 10: 421–423. *See, also,* L'Astron., 6: 430–434. *Also:* Bull. astron., 4: 468.

Astronomy (Descriptive).

Ball (R. S.) The story of the heavens. 2 ed., il. 8vo. London, 1887. (M. 32.50.)

Förster (W.) Sammlung von Vorträgen und Abhandlungen. 2 ed. 350 p. 8vo. Berlin, 1887. (M. 6.)

Jochmann (—) & Hermes (—.) Grundriss der Experimentalphysik und Elemente der Astronomie und mathematischen Geographie. 10. ed. 16 + 444 p. 8vo. Berlin, 1887. (M. 5.80.)

Lueders (F. G. J.) Memorial to the representatives of physical astronomy . . . 12 p. 8vo. Madison, 1887.

Parkes (S. H.) Unfinished worlds: a study in astronomy. il. 8vo. London, 1887. (M. 5.20.)

Proctor (R. A.) Half hours with the stars. New ed. 12 pl. 4to. New York, 1887.

—— Other suns than ours: series of essays on suns, old, young, and dead. 428 p. 8vo. London, 1887. (M. 7.80.)

Langley (S. P.) The new astronomy. The stars. il. Century, 33: 586–598. 1887, Jan.

—— Same. Comets and meteors. il. *Ibid.*, 339–355. 1887, Feb.

—— The new astronomy. 12 + 260 p. il. 8vo. Boston, 1888 [1887]. ($4.00.)

Liagre (J.) Cosmographie stellaire. 278 p., 4 maps. 12mo. Bruxelles, 1887. (M. 3.)

Lynn (W. T.) Celestial motions: handy book of astronomy. 5 ed. 12mo. London, 1887. (M. 2.20.)

Astronomy (Descriptive)—*Continued.*

MEYER (M. W.) Die Lebensgeschichte der Gestirne: eine populäre Astronomie der Fixsterne. 8 + 224 p. il. 8vo. Jena, 1887. (M. 4.)

NIESTEN (L.) Le ciel, son aspect, ses curiosités: atlas élémentaire . . . avec texte explicative . . . 4to. Bruxelles, 1887. (fr. 5.)

VON SEEFELD (F. S.) Astronomische Aufsätze eines Amateurs der Naturwissenschaft. Hft. 1. 54 p. 8vo. Gratz, 1887. (M. 0.80.)

SERVISS (G. P.) Astronomy with an opera glass. il. Pop. sc. month., 30: 743; *Ibid.*, 31: 187, 478; *Ibid.*, 32: 53.

VALENTINER (W.) Der gestirnte Himmel: eine gemeinverständliche Astronomie. 7 + 327 p. il. 8vo. Stuttgart, 1887. (M. 6.)

Astronomy (History of). *See, also,* Astronomy (Progress of).

BONNEL (J. F.) Étude sur l'histoire de l'astronomie: la découverte du double mouvement de la terre. 208 p. 8vo. Tours, 1887.

CLERKE (A. M.) History of astronomy during the 19th century. 2 ed., enl. 16 + 502 p. il. 8vo. Edinburgh, 1887. (M. 13.)

—— Homeric astronomy. Nature, 35: 585, 607.

LOOFF (F. W.) Die Himmelskunde in ihrer geschichtlichen Entwicklung und nach ihrem gegenwärtigen Standpunkte. 8 + 132 p., 2 pl. 8vo. Langensalza, 1887. (M. 2.)

Astronomy (Progress of).

ALLEN (Grant.) Progress of science from 1836 to 1886. Pop. sc. month., 31: 505, 513–515.

KLEIN (H. J.) Fortschritte der Astronomie. Nr. 12, 1886. 112 p. 12mo. Leipzig, 1887. *Repr. from:* Rev. d. Naturwissensch., Nr. 71.

SWIFT (L.) Astronomical progress and phenomena [1886]. Appleton's ann. cycl., 1886. 24 (n. s. 11): 48–59.

Astronomy (Spherical and practical). *See, also,* Azimuth; Illumination; Navigation, etc.

GOODWIN (H. B.) Problems in navigation and nautical astronomy. 86 p. 8vo. London, 1887. (M. 5.30.)

HERR (J. P.) & TINTER (W.) Lehrbuch der sphärischen Astronomie in ihrer Anwendung auf geographische Ortsbestimmung. 644 p. il. 8vo. Wien, 1887. (M. 16.)

JEANS (H. W.) Problems in astronomy, surveying and navigation . . . Part 1. 244 p. 8vo. London, 1887. (M. 2.70.)

OLIVER (J. A. W.) & *others.* Astronomy for amateurs: practical manual of telescopic research . . . adapted to moderate . . . instruments. 7 + 316 p. il. 12mo. London, 1888 [1887]. (M. 7.80.)

Astronomy (Theoretical). *See, also,* Lunar theory; Mechanics (Celestial); Orbits.

ISRAEL-HOLTZWART (K.) Supplement zu den Elementen der theoretischen Astronomie. Insbesondere, analytische Theorie der Anziehung der Sphäroide von konstanter und veränderlicher Dichtigkeit. 100 p. 8vo. Wiesbaden, 1887. (M. 1.60.)

Auerbach (Carl Heinrich August) [1813–1886].

Weinek (L.) [Biographical sketch.] Vrtljschr. d. astron. Gesellsch., 22: 6–9.

Aurora.

Clerke (A. M.) The aurora borealis. Nature, 35: 433–436.

Lagrange (E.) Aurores boréales, comètes et étoiles filantes. Ciel et terre, 7: 494–500.

Rendall (R.) Noises accompanying auroræ. Obsry., 10: 303.

Webber (H. J.) Noises accompanying auroræ. *Ibid.*, 10: 161.

Azimuth.

Craig (J. E.) Azimuth: a treatise on this subject, with a study of the astronomical triangle, and of the effect of errors in the data. 4 + 107 p. +. 4to. New York, 1887.

Bamberg observatory.

Hartwig (E.) Über die Bamberger Sternwarte. il. Vrtljschr. d. astron. Gesellsch., 22: 329–335. *See, also*, Obsry., 10: 279.

Basel observatory.

[Report for 1886.] Vrtljschr. d. astron. Gesellsch., 22: 75.

Baxendell (Joseph) [1815–1887].

Espin (T. E.) [Biographical notice.] Astron. Nachr., 118: 175.

Stewart (B.) [Biographical notice.] Nature, 36: 585.

Berlin observatory.

Förster (W.) [Report for 1886.] Vrtljschr. d. astron. Gesellsch., 22: 75–85.

Jesse (O.) Über die Biegung des Rohres und des Kreises des kleineren Meridian-Instrumentes der Berliner Sternwarte, sowie über die Biegung der bei dieser Bestimmung benutzten Collimatoren. Astron. Nachr., 117: 33–40, 135.

Bermerside observatory.

[Report for 1886.] Month. not., 47: 160.

Bethlehem (Star of).

Ellis (J. T.) [Hypotheses in regard to the star of Bethlehem.] Sid. mess., 6: 360.

Payne (W. W.) Star of Bethlehem. Sid. mess., 6: 265–269.

[Venus mistaken for] the star of Bethlehem. Nature, 37: 169; Obsry., 11: 96; Eng. mec., 46: 388, 390.

Birr castle observatory.

[Report for 1886.] Month. not., 47: 160.

Bonn observatory.

Schönfeld (E.) [Report for 1886.] Vrtljschr. d. astron. Gesellsch., 22: 89–92.

Bordeaux observatory.

Annales de l'observatoire de Bordeaux, publiées par G. Rayet. Tome 2 159 + 306 p. 4to. Paris, 1887.

di Brera observatory.

Pubblicazioni . . . No. 31. Azimut assoluto del segnale trigonometrico del monte Palanzone sull' orizzonte di Milano, determinato nell 1882 da M. Rajna. 125 p. 4to. Milano, 1887.

Pubblicazioni . . . No. 32. Nuova triangolazione della citta di Milano eseguita da F. Borletti. 15 p., 4 pl. 4to. Milano, 1887.

Breslau observatory.

Galle (J. G.) [Report for 1886.] Vrtljschr. d. astron. Gesellsch., 22: 92.

Brussels observatory.

Folie (F.) [Report for 1885 and 1886.] Vrtljschr. d. astron. Gesellsch., 22: 93–99.

[Removal to Uccle.] Nature, 36: 41.

Calendar.

Abetti (A.) Nozioni sul calendario dei Cofti e degli Abissini cristiani. 9 p. 4to. Roma, 1887. (M. 1.)

Repr. from: Atti d. r. accad. d. Lincei, s. 4, Rendic., 3: 396–401.

Gérigny (P.) Reforme du calendrier: rapport sur les projets présentés au concours. L'Astron., 6: 212, 260, 293, 339, 384.

Poncet (G.) Pourquoi l'année commence-t-elle le 1er Janvier? L'Astron., 6: 378–382.

Cambridge [Eng.] observatory.

[Report for 1886.] Month. not., 47: 151.

Cambridge [U. S.] observatory. *See* Harvard college observatory.

Cape of Good Hope observatory.

[Report for 1886.] Month. not., 47: 164.

Carleton college observatory.

[Payne (W. W.) Description of the Repsold meridian circle, etc.] il. Sid. mess., 6: 302–306, 319.

Chromosphere. *See, also,* Prominences (Solar).

Perry (S. J.) [Observations of] the chromosphere in 1886. Obsry., 10: 129.

Chronodeik.

Verbesserung des Chronodeik. Sirius, 20: 108–112.

Chronographs.

Buckney (—) & *others.* [Remarks on chronograph of Melbourne observatory.] Obsry., 10: 49.

Herz (N.) Streifen-Ableseapparat. Astron. Nachr., 117: 263.

von Rebeur-Paschwitz (E.) Registrirapparat mit Centrifugal-Regulirung. il. Ztschr. f. Instrmknd., 7: 171.

Chronometers.

Cellérier (G.) Étude numérique des concours de compensation des chronomètres faits à l'observatoire de Genève en 1884 et 1886. 45 p. 4to. Genève. 1887. (Mém. soc. phys. et d'hist. nat. Genève, 29, no. 6.)

Ellery (R. L. J.) [Break-circuit chronometer devised and used in Australia in 1860.] Obsry., 10: 427.

Chronometers—*Continued.*

GAUTIER (E.) Rapport sur le concours pour le réglage des chronomètres, 1886. [11] p. 8vo. [n. p., 1887.]

HIRSCH (A.) Rapport du directeur de l'observatoire cantonal de Neuchâtel . . . sur le concours des chronomètres observés pendant l'année 1886. 28 + 12 p. 12mo. Locle, 1887.

PETERS (C. F. W.) Einfluss der Luftfeuchtigkeit auf den Gang der Chronometer. Vrtljschr. d. astron. Gesellsch., 22: 284–292.

Rates of chronometers on trial . . . at the Royal observatory, Greenwich. 7 p. 4to. [London, 1887.]

In: Greenw. obsns. 1885.

Recherches sur les chronomètres et les instruments nautiques. 123 p. 8vo. Paris, 1887. (M. 1.50.)

YOUNG (C. A.) [First use of] break-circuit chronometers. Obsry., 10: 140, 334.

Cincinnati observatory.

Publications of the Cincinnati observatory, 9. Zone catalogue of 4,050 stars for the epoch 1885 . . . by J. G. Porter. 104 p. 8vo. Cincinnati, 1887.

Circle-divisions.

REPSOLD (A.) Schreib-Apparat für Theilungs-Beyifferung il. Ztschr. f. Instrmknd., 7: 396.

Clark (Alvan) [1804–1887].

For Biography, *see* Am. j. sc., 134: 322. *Also:* Eng. mec., 45: 603. *Also:* Nation, 45: 149. *Also:* Nature, 36: 476. *Also:* Science, 10: 96. *Also:* Sc. Amer., 57: 145, 213. *Also:* Sid. mess., 6: 250–253. *Also:* Sirius, 20: 241.

For Portrait, *see* Science, 10: 96. *Also:* Sc. Amer., 57: 198.

Clocks.

APPEL (D.) Freie Schwerkraft-Hemmung der Normal-Stern-Uhr zu Princeton. Ztschr. f. Instrmknd., 7: 29.

BUCKNEY (T.) Note on the performance of the Westminster clock. Month. not., 47: 519.

CHRISTIE (W. H. M.) Method of regulating clocks. Obsry., 10: 326.

CORNU (A.) Synchronisation des horloges de précision et la distribution de l'heure. Compt. Rend., 105: 1106–1112, 1209.

FOLIE (F.) Sur l'enregistrement par microphone des battements d'une pendule. Bull. de l'acad. roy. de Belg. [1887 ?] *Notice:* Bull. astron., 4: 291.

GARDNER (H. D.) Fifty years' progress in clocks and watches. il. Nature, 36: 484.

WOLF (C.) Comparaison des divers systèmes de synchronisation électrique des horloges astronomiques. Compt. Rend., 105: 1155–1159, 1211.

Colored stars.

BACKHOUSE (T. W.) Proposed nomenclature for star-colors. Obsry., 10: 234.

CHAMBERS (G. F.) [Color of Achernar.] Obsry., 10, 301.

FRANKS (W. S.) Proposed nomenclature for star-colors. Obsry., 10: 275. *Also:* Month. not., 47: 269–272.

Colored stars—*Continued.*

FRANKS (W. S.) Report from colored star section. J. Liverp. astron. soc., 5: 227.

VON KÖVESLIGETHY (R.) Neue Methode der Farbenbestimmung der Sterne. Sirius, 20: 219, 271. *Also*, Reprint. (M. 0.40.)

MONK (W. H. S.) Colors of the stars and solar heat. Obsry., 10: 164.

WILLIAMS (A. S.) Color of Achernar. Obsry., 10: 272, 334.

Comet Olbers = Comet 1887 V (*f*).

Detected by Brooks at Phelps, N. Y., 1887, Aug. 24. Astron. jour., 7: 127. *Also:* Astron. Nachr., 117: 279. *Also:* Sc. Amer., 47: 181, 192. *Also:* Sid. mess., 6: 289.

Comet Olbers (Elements of).

EGBERT (H. V.) [From obsns. 1887, Aug. 26, 28, 30.] Astron. jour., 7: 128. *Also:* Sc. obsr. circ., 79. *See, also*, Sid. mess., 6: 294.

——— [Correcting Ginzel's elements by obsns. 1887, Aug. 27 to Sept. 23.] Astron. jour., 7: 135.

FRANZ (J.) [From obsns. 1887, Aug. 27, 28, 29.] Astron. Nachr., 117: 295.

GINZEL (F. K.) [Elements corrected by obsns. 1887, Aug. 27, Sept. 6, 14.] Astron. Nachr., 117: 390.

GRUEY (L. J.) [From obsns. 1887, Aug. 27, 30, Sept. 2.] Astron. Nachr., 117: 343.

KRÜGER (A.) [Ginzel's elements corrected by obsns. 1887, Aug. 27.] Astron. Nachr., 117: 309.

LEBEUF (A.) [From obsns. 1887, Aug. 27, 30, Sept. 2.] Astron. Nachr., 117: 343. *Also:* Bull. astron., 4: 427.

RAMBAUD (A. A.) & SY (—.) [From obsns. 1887, Aug. 29, 31, Sept. 2.] Compt. Rend., 105: 487.

TETENS (O.) [Ginzel's elements corrected by obsns. to Sept. 20.] Astron. Nachr., 117: 358.

Comet Olbers (Observations of position of).

Albany, Aug. 26–30; Astron. journ., 7: 128. Sept. 23; *Ibid.*, 136. Sept. 15, Nov. 1; *Ibid.*, 152.

Algiers, Aug. 29, 31, Sept. 2; Astron. Nachr., 117: 325. Aug. 29, 31; Compt. Rend., 105: 430. Sept. 10, 12, 13, 14, 16; *Ibid.*, 511. Sept. 17, 19, 21, 22; Bull. astron., 4: 466.

Besançon, Aug. 29, 30, Sept. 1; Astron. Nachr., 117: 341. *Also:* Compt. Rend., 105: 431. Sept. 14–17, 21, 22, 26, 30, Oct. 1; Compt. Rend., 105: 609.

Bordeaux, Sept. 8, 9, 10; Compt. Rend., 105: 456. Sept. 8, 9, 10, 15, 18, 19, 21, 23, 24, 25; *Ibid.*, 1001. *Also:* Astron. Nachr., 118: 109.

Bothkamp, Sept. 18, 20, 21, 23, 24; Astron. Nachr., 117: 387. Oct. 21, 26; *Ibid.*, 118: 105.

Geneva, Aug. 29; Astron. Nachr., 117: 293. Sept. 6; *Ibid.*, 307. Oct. 1, 17, 25, 27, Nov. 4; *Ibid.*, 118: 109.

Hamburg, Sept. 20; Astron. Nachr., 117: 355. Sept. 23, 24; *Ibid.*, 387.

Comet Olbers (Observations of position of)—*Continued.*

Kiel, Sept. 14; Astron. Nachr., 117: 327. Sept. 15, 18; *Ibid.*, 341. Sept. 20; *Ibid.*, 355.

Königsberg, Aug. 27, 28, 29; Astron. Nachr., 117: 295. Aug. 27, 28, 29, Sept. 10, 12; *Ibid.*, 341. Sept. 21, 27; *Ibid.*, 387. Oct. 8, 12, 14; *Ibid.*, 118: 42. Oct. 26, 27, Nov. 11; *Ibid.*, 118: 94.

Kremsmünster, Aug. 28; Astron. Nachr., 117: 293. Aug. 28, 30, Sept. 6, 10, 17; *Ibid.*, 118: 107.

Lyons, Aug. 30; Compt. Rend., 105: 432. Sept. 9, 10; *Ibid.*, 487. Sept. 13, 21, 22; *Ibid.*, 512.

Marseilles, Aug. 27, 29; Bull. astron., 4: 462. Aug. 29, 30, 31, Sept. 13, 15, 16, 18, 20, 22, 23, 26; *Ibid.*, 464.

Milan, Aug. 30, 31; Astron. Nachr., 117: 307.

Nashville, Aug. 27, 28; Astron. jour., 7: 127. *Also:* Astron. Nachr., 117: 327, 391.

Nice, Aug. 29–Sept. 2; Compt. Rend., 105: 456. *Also:* Bull. astron., 4: 467. Sept. 5, 6; Bull. astron., 4: 467.

Padua, Sept. 13, 14, 15, 24; Astron. Nachr., 117: 390.

Plonsk, Sept. 6; *Ibid.*, 327, 391.

Pulkowa, Sept. 25, Oct. 10, 15, 22, Nov. 13, 15; *Ibid.*, 118: 109

Rome, Aug. 27; Astron. Nachr., 117: 293.

Strassburg, Aug. 27; *Ibid.*, 293. Aug. 27, Sept. 14; *Ibid.*, 341.

Turin, Aug. 29; *Ibid.*, 293. Aug. 29, 31; *Ibid.*, 327. Sept. 10, 13, 15, 16, 17, 20; *Ibid.*, 118: 75.

Vienna, Aug. 27; *Ibid.*, 117: 294. Oct. 21; *Ibid.*, 118: 42.

Washington, Aug. 29, 30, 31, Sept. 16, 19; Astron. jour., 7: 134.

Comet Olbers (Orbit of). *See, also,* Comet Olbers (Elements of).

KRÜGER (A.) Wiederkehr des Olbers'schen Cometen. Astron. Nachr., 117: 310.

SEARLE (G. M.) Recent approach of the Olbers comet to Mars. Astron. jour., 7: 134.

Comet Temple. *See* Comets and Meteors.

Comet Winnecke.

VON HÄRDTL (E.) Bestätigen die neuesten Beobachtungen das Resultat Prof. von Oppolzer's: dass auch bei dem periodischen Cometen Winnecke, Encke's Hypothese des Widerstand leistenden Mediums Geltung zu haben scheine? Vrtljschr. d. astron. Gesellsch., 22: 313–319.

Comet 890 and Comet 1075.

GINZEL (F. K.) [Apparition of two historical comets, 890, May 23, and 1075, July–Aug.] Astron. Nachr., 118: 47.

Comet 1457 I.

SCHULHOF (L.) Orbites des comètes 1457 I et 1818 I. Bull. astron., 4: 51–54.

Comet 1672.

BERBERICH (A.) Der Comet des Jahres 1672. Astron. Nachr., 118: 50–72.

Comet 1680.

LYNN (W. T.) Comet of 1680 and its supposed previous appearances. Obsry., 10: 318.

Comet 1780 II.

LYNN (W. T.) The comet discovered by Montaigne and Olbers in 1780. Obsry., 10: 355.

Comet 1818 I. *See Comet* 1457 I.

Comet 1825 IV.

LYNN (W. T.) [Erratum in Carl's Repertorium.] Obsry., 10: 232.

Comet 1840 I.

GALLE (J. G.) Berichtigung zu den Angaben über die Zeit des Periheldurchganges . . . Astron. Nachr., 117: 167.

Comet 1846 IV.

VON HEPPERGER (J.) Bahnbestimmung des Cometen 1846 IV. 42 p. 8vo. Wien, 1887. (M. 0.70.)

Abstr.: Astron. Nachr., 117: 246.

Comet 1846 VI.

BERBERICH (A.) Bahn des Cometen 1846 VI, Peters. Astron. Nachr., 117: 249.

Comet 1848 I.

BIDSCHOF (F.) Bestimmung der Bahn des Cometen 1848 I. 17 p. 8vo. Wien, 1887. (*Abstr.:* Astron. Nachr., 117: 247.) (M. 0.40.)

Comet 1863 IV.

SVEDSTRUP (A.) Definitive Bahnbestimmung des Cometen 1863 IV. Astron. Nachr., 117: 222–242.

Comet 1865 I.

KÖRBER (F.) Über den Cometen 1865 I. 58 p. 8vo. Breslau, 1887. (M. 1.50.)

TEBBUTT (J.) Note on the tail . . . Astron. Nachr., 117: 385.

Comet 1877 VI.

LARSSÉN (R.) Bahn des Kometen 1877 VI. 24 p. 8vo. Stockholm, 1887.

Bihang. till k. svenska vet. akad. Handlingen. Bd. 12. Afd. I, No. 8.

Comet 1882 I.

VON REBEUR-PASCHWITZ (E.) Über die Bahn des Cometen 1882 I. Astron. Nachr., 117: 281–287. Rev.: Bull. astron., 4: 448.

Rev.: Bull. astron., 4: 448.

Comet 1883 II.

BRYANT (R.) [Elliptic elements from normals 1884, Jan. 19, Jan. 25, Feb. 2.] Month. not., 47: 434.

TENNANT (J. F.) [Note on the orbit.] *Ibid.*, 520.

Comet 1884 III.

BERBERICH (A.) Elemente . . . aus den Strassburger Beobachtungen . . . Astron. Nachr., 117: 251.

THRAEN (A.) Definitive Bahnbestimmung des Cometen 1884 III, Wolf. Astron. Nachr., 117: 65–98.

Comet 1886 I.

MORRISON (J.) [Hyperbolic elements from obsns. 1885, Dec. 7, to 1886, June 6.] Month. not., 47: 437.

Comet 1886 III.

CELORIA (G.) [Elements from normals 1886, May 4, 10, 22.] Astron. Nachr., 117: 9.

Comet 1886 V.

WILSON (H. C.) The comets of De Vico, 1844 I, and Finlay, 1886 V. il. Sid. mess., 6: 121-126.

Comet 1886 VII.

BOSS (L.) Orbit of the periodic comet 1886, *e*, Finlay. Astron. jour., 7: 23, 43.

See, also, Astron. jour., 7: 7.

FINLAY (W. H.) [Elements from normals 1886, Sept. 28, Dec. 15, and observations Oct. 21, Nov. 13, Dec. 27. Month. not., 47: 302.

HOLETSCHEK (J.) [Elements from obsns. 1886, Sept. 26, Oct. 14, Oct. 29, Nov. 28.] Astron. Nachr., 116: 47.

KRÜGER (A.) [Elements from obsns. to 1887, Feb. 23.] *Ibid.*, 335.

See, also, Astron. Nachr., 116: 77, 127.

MONCK (W. H. S.) [Resemblance of elements to those of comet of 1585.] Sid. mess., 6: 222.

OPPENHEIM (H.) Elements from obsns. 1886, Oct. 1, Nov. 1, 7, 27.] Astron. Nachr., 116: 45.

SEARLE (G. M.) [Elements from obsns. 1886, Sept. 26, Oct. 16, Nov. 4.] Astron. jour., 7: 15.

——— [Elements from obsns. 1886, Sept. 26, Nov. 4, Dec. 14.] *Ibid.*, 52.

Comet 1886 VIII = Comet 1887 *c*.

Discovered by Barnard at Nashville, 1887, Jan. 23. Astron. jour., 7: 56. *Also:* Astron. Nachr., 116, 143. *Also:* Sid. mess., 6: 114.

Comet 1886 VIII (Elements of).

CHARLOIS (A.) [Elements from obsns. 1887, Jan. 26, 29, Feb. 1.] Bull. astron., 4: 58.

EGBERT (H. V.) [Elements from obsns. 1887, Jan. 23, 24, 26.] Astron. jour., 7: 64.

——— [Elements from obsns. 1887, Jan. 23, 26, 30.] *Ibid.*, 71.

——— [Elements from obsns. 1887, Jan. 24, Feb. 18, Mar. 20.] *Ibid.*, 87.

OPPENHEIM (H.) [Elements from obsns. 1887, Jan. 24, 29, Feb. 3.] Astron. Nachr., 116: 175. *Also:* Obsry., 10: 144.

WEISS (E.) [Elements from obsns. 1887, Jan. 24, 26, 29.] Astron. Nachr., 116: 159.

——— [Elements from two normals 1887, Jan. 24-30, and observation Feb. 3.] *Ibid.*, 191.

Comet 1886 IX.

ALLEN (W. H.) [Elements from normals 1886, Oct. 8, Nov. 3, Dec. 2, Dec. 10.] Astron. jour., 7: 55.

Comet 1886 IX—*Continued.*

BREDICHIN (T.) [Discussion of observations of the tail.] 7 p., 1 pl. 8vo. Moscou. 1887.

MORRISON (J.) [Elements from obsns. 1886, Oct. 7–Dec. 2.] Month. not., 47: 438.

SVEDSTRUP (A.) [Elements from normals 1886, Oct. 8, 28, Nov. 18.] Astron. Nachr., 116: 15.

WENDELL (O. C.) [Elements from obsns. 1886, Oct. 7, Nov. 6, Dec. 10.] *Ibid.*, 117: 59.

Comet 1887 I = 1887 *a.*

Discovered by Thome at Cordoba, 1887, Jan. 18. Astron. jour., 7: 55. *Also:* Astron. Nachr., 116: 143. *Also:* Obsry., 10: 112.

See, also (independent discovery near Cape Town), Month. not., 47: 303.

Comet 1887 I (Elements and Orbit of).

CHANDLER (S. C.) jr. [Elements from obsns. 1887, Jan. 20–29.] Astron. jour., 7: 93.

——— [Elements from Cape and Adelaide obsns. combined into normals, 1887, Jan. 22, 25, 27.] *Ibid.*, 100.

FINLAY (W. H.) [Elements from obsns. 1887, Jan. 22, 25, 28.] Month. not., 47: 304.

OPPENHEIM (H.) Über die Bahn des grossen Südcometen 1887 I. Astron. Nachr., 117: 13.

R. (A. W.) The present southern comet. Nature, 35: 438.

Comet 1887 I (Observations of position of). 1887.

Adelaide, Jan. 21, 22, 25, 26, 27; Month. not., 47: 305.

Cape of Good Hope, Jan. 22–25, 27, 28; *Ibid.*, 303.

Cordoba, Jan. 21, 22, 24, 25, 27; Astron. jour., 7: 91. *Also:* Astron. Nachr., 117: 259.

MOLONY (E. J.) [Observations with sextant Jan. 21, 22, 25.] Month. not., 47: 432.

Comet 1887 I (Physical appearance of).

BIGGS (A. B.) [General description.] Eng. mec., 45: 174.

F[LAMMARION] (C.) La grande comète australe de 1887. il. L'Astron., 6: 201–203.

[Rio Janeiro observations, with sketch.] Rev. d. obsrio., 2: 17.

TEBBUTT (J.) [Description of a large southern comet.] Obsry., 10: 166.

THOME (J. M.) O grande cometa austral. Rev. d. obsrio., 2: 35.

Comet 1887 II = Comet 1887 *b.*

Discovered by Brooks at Phelps, N. Y., 1887, Jan. 22. Astron. jour., 7: 55. *Also:* Astron. Nachr., 116: 143. *Also:* Sid. mess., 6: 113.

Comet 1887 II (Elements of).

BERBERICH (A.) [From obsns. 1887, Jan. 25, 26, 28.] Astron. Nachr., 116: 159.

BOSS (L.) [From obsns. 1887, Jan. 24, 26, 29.] *Ibid.*, 116: 160.

Comet 1887 II (Elements of)—*Continued.*

Boss (L.) [From obsns. 1887, Jan. 24, 29, Feb. 9.] Astron. jour., 7: 63.

——— [From obsns. 1887, Jan. 24, Feb. 15 (4 obsns.), Mar. 12.] *Ibid.*, 85.

OPPENHEIM (H.) [From obsns. 1887, Jan. 25, 27, 29.] Astron. Nachr., 116: 174. *Also:* Obsry., 10: 148.

——— [From obsns. 1887, Jan. 25, 27, 29, Feb. 11.] Astron. Nachr., 116: 221.

——— [From obsns. 1887, Jan. 25, Feb. 11, Mar. 11, 28.] *Ibid.*, 317.

SPITALER (R.) [From obsns. 1887, Jan. 25, 27, 29.] *Ibid.*, 173.

——— [From obsns. 1887, Jan. 25, 26, Feb. 12.] *Ibid.*, 206.

——— [From normals 1887, Jan. 24, Feb. 11, and an observation Feb. 25.] *Ibid.*, 253.

Comet 1887 II (Observations of position of). 1887.

Albany, Jan. 24, 26, 27, 29, Feb. 9; Astron. jour., 7: 56, 61. Mar. 12; *Ibid.*, 85.

Algiers, Jan. 27, 28; Compt. Rend., 104: 348. Jan. 27, 28, Feb. 19, 21, 23, 26, Mar. 14; Bull. astron., 4: 136. Mar. 18, 21–25, Apr. 13, 14; *Ibid.*, 423.

Berlin, Feb. 11; Astron. Nachr., 116: 189.

Besançon, Feb. 24, 26, 28, Mar. 1, 2, 18, 29, Apr. 10, 18, 20; Compt. Rend., 105: 738.

Bethlehem, Feb. 9, 13, 19; Astron. jour., 7: 80.

Bordeaux, Jan. 29; Astron. Nachr., 116: 157. *Also:* Compt. Rend., 104: 277. Jan. 30, Feb. 4, 5, 7, 9, 10, 11; Compt. Rend., 104; 417. Jan. 29, 30, Feb. 4, 5, 7, 9, 10, 11, 13, 15, 16, 17, 24, 26, 27, Mar. 2, 3, 4, 7, 16, 17, 18, 25, 28, 30; Astron. Nachr., 117: 99.

Bothkamp, Mar. 19, 20; Astron. Nachr., 118: 105.

Cambridge (Harv. coll. obsry.), Jan. 24, 27; *Ibid.*, 116: 191.

Copenhagen, Feb. 13, Mar. 16; *Ibid.*, 118: 73.

Dresden, Feb. 15; Astron. Nachr., 116: 203. Feb. 19; *Ibid.*, 249. Mar. 11; *Ibid.*, 267. Mar. 24; *Ibid.*, 317, 327.

Geneva, Feb. 10, 11, 12, 14, 17, 18, 21–24, 26, 28, Mar. 18, 29–31; Astron. Nachr., 116: 333. Apr. 18, 20; *Ibid.*, 117: 55.

Göttingen, Feb. 15; Astron. Nachr., 116: 203. Feb. 14, 17, 24; *Ibid.*, 249. Mar. 11, 15; *Ibid.*, 116: 267. Feb. 14–18, 24, 28, Mar. 1, 11, 15; *Ibid.*, 117: 149.

Greenwich, Feb. 27, 28; Month. not., 47: 275. Mar. 13, 16, 18, 23, 24, 27; *Ibid.*, 392.

Hamburg, Feb. 13, 15; Astron. Nachr., 116: 203.

Kiel, Jan. 27; *Ibid.*, 157. Feb. 10, 11; *Ibid.*, 189. Feb. 15; *Ibid.*, 203.

Kremsmünster, Jan. 24–30; Astron. Nachr., 117: 149. Feb. 12, 14, 15–18, 24, Mar. 1, 2, 4, 21; *Ibid.*, 118: 105.

Milan, Jan. 27; *Ibid.*, 116: 173.

Nashville, Jan. 23; Astron. jour., 7: 63. *Also:* Astron. Nachr., 116: 203

Nice, Jan. 27–29; Bull. astron., 4: 135.

Orwell Park, Feb. 12, 13, 15, 16, 17, 21, 24–28, Mar. 1, 2, 6, 10, 11, 12, 14, 16, 18, 23, 25, 27, 28, 30, Apr. 10, 11, 15, 16, 17, 20, 23; Month. not., 48: 58.

Comet 1887 II (Observations of position of). 1887—*Continued.*

Padua, Jan. 27–30; Astron. Nachr., 116: 171.

Palermo, Jan. 29–31; *Ibid.*, 219. Feb. 15, 24; *Ibid.*, 265.

Paris, Jan. 27; Astron. Nachr., 116: 173. Jan. 27, 28, 29; Compt. Rend., 104: 276.

Plonsk, Feb. 11, 14, 17, 20, 25; Astron. Nachr., 117: 305.

Strassburg, Jan. 25–28; *Ibid.*, 116: 143, 157. Feb. 11; *Ibid.*, 203.

Toulouse, Jan. 27–31, Feb. 4; Compt. Rend., 104: 487.

Vienna, Jan. 28, 29; Astron. Nachr., 116: 173. Feb. 12; *Ibid.*, 205. Feb. 18: *Ibid.*, 203.

Washington, Jan. 24, 25; Astron. jour., 7: 62. Feb. 12, 16, 18; *Ibid.*, 78. Mar. 11, 12; *Ibid.*, 86.

Comet 1887 III = Comet 1887 *d.*

Discovered by Barnard at Nashville, 1887, Feb. 16. Astron. jour., 7: 72. *Also:* Astron. Nachr., 116: 207, 251. *See, also*, Sid. mess., 6: 161.

Comet 1887 III (Elements of).

Barnard (E. E.) [From obsns. 1887, Feb. 16, 18, 22.] Sid. mess., 6: 161.

——— [From obsns. 1887, Feb. 16, 28, Mar. 8.] Astron. jour., 7: 95.

——— [From obsns. 1887, Feb. 16, 28, Mar. 12.] Astron. Nachr., 117: 59.

Boss (L.) [From obsns. 1887, Feb. 16, 18, 20.] Astron. Nachr., 116: 207. *Also:* Obsry., 10: 144.

——— [From obsns. 1887, Feb. 16, 19, 22.] Astron. jour., 7: 72. *Also:* Astron. Nachr., 116: 223.

Oppenheim (H.) [From obsns. 1887, Feb. 17, 23, 26.] Astron. Nachr., 116: 255.

——— [From obsns. 1887, Feb. 17, 28, Mar. 11.] *Ibid.*, 271.

Palisa (J.) [From obsns. 1887, Feb. 17, 23, 28.] *Ibid.*, 256.

Wendell (O. C.) [From obsns. 1887, Feb. 22, 25, 28.] *Ibid.*, 317.

Comet 1887 III (Observations of position of). 1887.

Albany, Feb. 19, 22, 25; Astron. jour., 7: 84.

Algiers, Feb. 24, 26; Compt. Rend., 104: 671. Feb. 24, 26, Mar. 12, 13, 14; Bull. astron., 4: 137. Mar. 21–25; *Ibid.*, 424.

Berlin, Feb. 28; Astron. Nachr., 116: 251.

Cambridge (Harv. coll. obsry.), Feb. 17, 19, 25, 28; Astron. jour., 7: 72, 79. *Also:* Astron. Nachr., 116: 267.

Copenhagen, Mar. 16; Astron. Nachr., 118: 73.

Dresden, Feb. 24; *Ibid.*, 116: 221. Mar. 11; *Ibid.*, 267. Mar. 24; *Ibid.*, 317.

Geneva, Feb. 24, 26; *Ibid.*, 116: 251. Mar. 18; *Ibid.*, 315.

Göttingen, Feb. 24; *Ibid.*, 116: 221.

Greenwich, Feb. 28; Month. not., 47: 275.

Hamburg, Feb. 26; Astron. Nachr., 116: 221.

Kremsmünster, Feb. 24, 25; *Ibid.*, 117: 149.

Nashville, Feb. 16, 18, 22; Astron. jour., 7: 79. *Also:* Astron. Nachr., 116: 251.

Comet 1887 III (Observations of position of). 1887—*Continued.*

Nice, Feb. 28, Mar. 1; Bull. astron., 4: 194.

Orwell Park, Feb. 28, Mar. 13, 14, 16, 18, 19, 23, 27, Apr. 10; Month. not., 48: 61.

Palermo, Feb. 27.; Astron. Nachr., 116: 267.

Paris, Feb. 17; Astron. Nachr., 116: 207. Feb. 17, 24, 27; Compt. Rend., 104: 559.

Rome, Feb. 24; Astron. Nachr., 116: 251. Feb. 25; *Ibid.*, 117: 270.

Strassburg, Feb. 23; *Ibid.*, 116: 221. Mar. 14; *Ibid.*, 267.

Vienna, Feb. 24; *Ibid.*, 221. Feb. 28; *Ibid.*, 251.

Washington, Feb. 24; Astron. jour., 7: 78.

Comet 1887 IV = Comet 1887 *e*.

Discovered by Barnard at Nashville, 1887, May 12. Astron. jour., 7: 96. *Also:* Astron. Nachr., 117: 31. *Also:* Sid. mess., 6: 220.

Comet 1887 IV (Elements of).

ABETTI (A.) [From obsns. 1887, May 14, 18, 21.] Astron. Nachr., 117: 102.

BIGELOW (F. H.) [Three normals from obsns. 1887, June 12–22.] Sid. mess., 6: 321.

BOSS (L.) [From obsns. 1887, May 12, 14, 15.] Astron. jour., 7: 96.

CHANDLER (S. C.) jr. [From normals 1887, May 14, 19, 24, 30.] Astron. jour., 7: 104.

——— [From normals 1887, May 14, 30, June 12, July 12.] *Ibid.*, 121.

——— [Elliptic elements from normals 1887, May 14, June 12, July 12.] *Ibid.*, 122.

LAMP (E.) [From obsns. 1887, May 12, 14, 16.] Astron. Nachr., 117: 31.

OPPENHEIM (H.) [From obsns. 1887, May 12, 15, 17.] *Ibid.*, 46.

——— [From normals 1887, May 14, 19, and an observation May 23.] *Ibid.*, 61.

——— [From obsns. 1887, May 14, 19, 23, June 16.] *Ibid.*, 119.

OPPENHEIM (S.) [From obsns. 1887, May 12, 14, 15, 17.] Astron. Nachr., 117: 45.

——— [From obsns. 1887, May 12, 17, 22, 29.] *Ibid.*, 62.

——— [From normals 1887, May 15, 22, 29, June 24.] *Ibid.*, 165.

WENDELL (O. C.) [From obsns. 1887, May 13, 19, 25.] *Ibid.*, 119.

Comet 1887 IV (Observations of position of). 1887.

Albany, May 13, 15, 18, 23; Astron. jour., 7: 103.

Algiers, May 16, 18–21, 23, 24; Astron. Nachr., 117: 57. *Also:* Compt. Rend., 104: 1493. May 25, 26, 28, June 9, 10, 15, 16, 20, 22, 23; Bull. astron., 4: 424. Aug. 8, 9; Bull. astron., 4: 465.

Berlin, May 23; Astron. Nachr., 117: 48. June 16, 24, 26; *Ibid.*, 117: 385.

Besancon, June 13, 14, 16, 17, 18, 20–24, July 8, 12, 16, 23; Compt. Rend., 105: 513.

Comet 1887 IV (Observations of position of). 1887—*Continued.*

Bordeaux, May 22, 26, 27, June 8–18, 21, 22; Astron. Nachr., 117: 151. *Also:* Compt. Rend., 104: 1822. June 28–July 2, 6, 7, 11, 12, 13, 19, 22, 23, 24, 27, 29, Aug. 6, 8, 10; Astron. Nachr., 117: 307. *Also:* Compt. Rend., 105: 403.

Bothkamp, June 15, 16, 24; Astron. Nachr., 117: 133. June 28, July 25; *Ibid.*, 215.

Cambridge (Chandler), May 30, July 12; Astron. jour., 7: 152.

Cambridge (Harv. coll. obsry.), May 13, 14, 19, 25, 30; Astron. jour., 7: 111. *Also:* Astron. Nachr., 117: 243. June 7, 8, 13, 14, 15, 25; Astron. jour., 7: 119. *Also:* Astron. Nachr., 117: 243.

Cape of Good Hope, May 19, 21, 23, 24, 27, June 8, 9, 11, 13, 14, 16, 17; Astron. Nachr., 117: 339.

Dresden, May 19; *Ibid.*, 43. May 22; *Ibid.*, 59. June 13; *Ibid.*, 133. July 16; *Ibid.*, 215.

Geneva, May 19; *Ibid.*, 43.

Gohlis, June 13, 14, 16–19, 22, 25; Astron. Nachr., 117: 214.

Göttingen, June 15–17, 22; *Ibid.*, 133.

Greenwich, June 12, 18, 19; *Ibid.*, 215.

Hamburg, June 16, 17, 19; *Ibid.*, 119, 133.

Harrow, June 12, 15, 17, 19, 22. Month. not., 47: 550.

Kiel, May 14; Astron. Nachr., 117: 31. May 16, 21; *Ibid.*, 43.

Kremsmünster, May 15, 26, June 13, 15, 18, 19, 23, 24, 25, 27, July 12; *Ibid.*, 118: 107.

Marseilles, May 14, 18, 22, 23, 24, 27, June 8–13, 15, 16, 17, 22, 28; Bull. astron., 4: 462.

Nashville, May 12, 13, 14; Astron jour., 7: 99. *Also:* Astron. Nachr., 117: 57. May 12, 13, 14, 18, 24, 25, 26, 28, June 9, 10, 11, 16, 17, 18, 20, 23; Astron. jour., 7: 111. *Also:* Astron. Nachr., 117: 243. July 8, 9, 11, 13–16, 19, 20, 26, Aug. 10, 11; Astron. jour., 7: 126. *Also:* Astron. Nachr., 117: 385.

Nice, May 14; Astron. Nachr., 117: 43. May 14, 17, 18, 20–23; Bull. astron., 4: 225. May 27, July 7, 11, 18, 23; *Ibid.*, 380.

Nicolaief, May 14, 15, 17, 18, 21; Astron. Nachr., 117: 55.

Orwell Park, June 9, 10, 12, 13, 15, 17, 18, 20, 22, July 11, 12, 13, 14, 18–21, 24, 27, 28; Month. not., 48: 61.

Padua, May 14; Astron. Nachr., 117: 43. May 18, 21; *Ibid.*, 101.

Palermo, May 15, 21; *Ibid.*, 31, 59. May 28, 30, 31; *Ibid.*, 101.

Paris, May 14; Astron. Nachr., 117: 43. *Also:* Compt. Rend., 104: 1360.

Prague, May 27; Astron. Nachr., 117: 59.

Rome, May 14, 15; Astron. Nachr., 117: 43. May 17, 19, 27, 30, June 7, 15, 18; *Ibid.*, 270. May 14, 15, 17, 19, 27, 30, June 7; Atti. d. r. accad. d. Lincei, s. 4. Rendic., 3: 481. July 8, 10–17, 21, 22, 24, Aug. 6, 7; Astron. Nachr., 117: 275.

Scarborough, May 20, 21, 29; Month. not., 47: 498.

Comet 1887 IV (Observations of position of). 1887—*Continued.*

Strassburg, May 15; Astron. Nachr., 117: 31.

Vienna, May 15, 17; *Ibid.*, 43.

Washington, May 14, 19, 21; Astron. jour., 7: 101.

Comet 1887 V = Comet 1887 *f*. *See* Comet Olbers.

Comets. *See, also,* Comets and meteors; Comets (Orbits of).

BERBERICH (A.) Methode sonnennahe Cometen bei Tage aufzufinden. Astron. Nachr., 118: 71.

CLEVINGER (S. V.) Optical appearances of comets. Sid. mess., 6: 89-95, 120.

DELAUNEY (J.) Sur les distances des planètes au soleil, et sur les distances des comètes periodiques. *Abstr.:* Compt. Rend., 105: 515.

GUILLEMIN (A.) Les comètes. 12 + 287 p. il. 8vo. Paris, 1887. (M. 1.20.)

HOLETSCHEK (J.) Über die Frage nach der existenz von Cometensystemen. Anzeiger der Wiener Akad. 1887, Nr. 15.

Rev.: Astron. Nachr., 117: 359.

KIRKWOOD (D.) Note on the origin of comets. Am. j. sc., 133: 60. *Also:* Sid. mess., 6: 77.

MONCK (W. H. S.) [Connection of comets and asteroids.] Obsry., 10: 230.

UNTERWEGER (J.) Zur Kometen-statistik. [Comets and the periodicity of sun-spots.] K. Akad. d. Wissensch. in Wien, sitzng. d. math.-naturwissen. Cl. 21 Julie 1887. *Also:* Mem. soc. spettroscp. ital., 16: 99-101. *Also, abstr.:* Sirius, 20: 227.

WILLIAMS (G. O.) [Cometary phenomena reproduced by reflections from spherical surfaces.] il. Sc. Am. sup., 9732.

Comets and meteors.

BUSZCZYNSKI (B.) Eine wahrscheinliche Periodicität von hellen Meteoren und ihr wahrscheinlicher Zusammenhang mit dem periodischen Cometen Tempel. Astron. Nachr., 115: 263, 309. *See, also, Ibid.*, 116: 101.

HIRSCH (A.) Les météores de Biela, 27 nov., 1885. Bull. soc. sc. nat. de Neuchatel, 15: 186-189.

KIRKWOOD (D.) Biela's comet and the large meteors of Nov. 27-30. Proc. Am. phil. soc., 24: 242.

——— Note on the possible existence of fireballs and meteorites in the stream of Bielids. *Ibid.*, 436.

LAGRANGE (E.) Aurores boréales, comètes et étoiles filantes. Ciel et terre, 7: 494-500.

Meteoros de 13-14 de Novembro. il. Rev. d. obsrio., 2: 168.

VON NIESSL (G.) Über die grossen Meteore im Juni und ihre vermuthete Beziehung zum periodischen Cometen Tempel. Astron. Nachr., 116: 97-102.

PROCTOR (R. A.) Origin of comets and meteors. Knowl., 10: 64, 135. *Also:* Pop. sc. month., 31: 50-60.

WENDELL (O. C.) [Radiants of the comets of 1886.] Astron. Nachr., 118: 175. *Also:* Sid. mess., 6: 359.

Comets of 1886.

B[IGOURDAN] (G.) Comètes et planètes de 1886. Bull. astron., 4: 15.

Comets of 1886—*Continued.*

KREUTZ (H.) Zusammenstellung der Cometen-Erscheinungen des Jahres 1886. Vrtljschr. d. astron. Gesellsch., 22: 14–23. *Also, transl.:* Sid. mess., 6: 201–210. *Also*, Reprint.

P. (W. E.) Comets of 1886. Month. not., 47: 172.

WINLOCK (W. C.) [List of the] comets of 1886. Sid. mess., 6: 112.

Comets (Orbits of). *See, also*, Orbits.

EVANS (W. C.) Motion of a comet when perturbed and resisted. Obsry., 10: 130–134.

HARKNESS (W.) Representation of comets' orbits by models. il. Sid. mess., 6: 329–349.

HOLETSCHEK (J.) Richtungen der grossen Achsen der Kometbahnen. 29 p. 8°. Wien, 1887. (M. 0.60.)

HOOVER (W.) Cometary perturbations. 18 p. 8vo. Wooster, Ohio, 1887.

KREUTZ (H.) Bericht über Cometen. Vrtljschr. d. astron. Gesellsch., 22: 361–365.

MONCK (W. H. S.) Inclinations of cometary orbits. Month. not., 47: 433.

——— Orbits of comets. Obsry., 10: 324.

SEARLE (G. M.) Method of computing an orbit from three observations. Astron. jour., 7: 140–144, 153–155.

Constellations.

LYNN (W. T.) [Babylonian origin of the constellations.] Obsry., 10: 162.

Copenhagen observatory.

THIELE (T. N.) Bestimmung der Längen-Differenz zwischen Lund und Kopenhagen. 56 p. 4to. Lund, 1886. (M. 2.)

Cordoba observatory.

GOULD (B. A.) Corrections to the Uranometria Argentina and the Cordoba catalogues. Astron. Nachr., 116: 379.

Resultados del observatorio nacional Argentino en Córdoba bajo la direccion del B. A. Gould. J. M. Thome, director. Vol. 5. Observaciones del año 1874. 180 + 559 p. 4to. Buenos Aires, 1886. (M. 80.)

——— Same. Vol. 6. Observaciones del año 1875. 44 + 649 p. 4to. Buenos Aires, 1887.

——— Same. Vol. 9. Observaciones del año 1876. 22 + 261 p. 4to. Buenos Aires, 1887.

Corona (Solar).

ENNIS (J.) Colors in the solar corona. Sid. mess., 6: 273–281.

WESLEY (W. H.) The solar corona as shown in photographs taken during total eclipses. Month. not., 47: 499–510.

Discussed: Obsry., 10: 251.

Cosmogony. *See, also*, Nebular hypothesis.

BRAUN (C.) Uber Cosmogonie vom Standpunkt christlicher Wissenschaft, mit einer Theorie der Sonne. 167 p. 8vo. Munster, 1887.

Rev. by Clerke (A. M.) Nature, 36: 321, 341. *See, also*, Bull. astron., 4: 141–143. *Also:* Obsry., 10: 201.

Cosmogony—*Continued.*

FLAMMARION (C.) L'univers antérieur. L'Astron., 6: 41–48.

GANSER (A.) Die Entstehung der Bewegung: eine Kosmogonie. 15 p. 8vo. Graz, 1887. (M. 1.)

LAGRANGE (C.) Une réflexion au sujet de la conception purement mécanique de l'univers. Ciel et terre, 8: 345–353.

ZENGER (C. V.) L'évolution sidérale. Compt. Rend., 105: 1289.

Dearborn observatory.

[Proposed transfer of instruments, etc.] Sid. mess., 6: 81, 324.

Reports (Annual) of the board of directors of the Chicago astronomical society, together with the report of the director of the Dearborn observatory for 1885 and 1886. 50 p. il. 8vo. Chicago, 1887.

Domes.

TODD (D. P.) Best device for revolving a dome. il. Month. not., 47: 272–274.

Discussed: Obsry., 10: 90.

Dorna (Alessandro) [1825–1886].

SIACCI (F.) Alessandro Dorna. Commemorazioni e catalogo delle sue pubblicazioni. 8 p. 8vo. Torino, 1887.

Dorpat observatory.

Beobachtungen der kaiserlichen Universitäts-Sternwarte Dorpat. 17. Bd. Reducirte Beobachtungen am Meridiankreise von Zonensternen und mittlere Örter derselben fur 1875–6, . . . von L. Schwarz. 39 + 151 + 47 p. 4to. Dorpat, 1887.

Double stars.

FRANKS (W. S.) Magnitudes of double stars. J. Liverp. astron. soc., 5: 44–47.

GORE (J. E.) Masses and distances of the binary stars. *Ibid.*, 47.

HALL (A.) Nomenclature of double stars. Astron. jour., 7: 120.

LIHOU (B.) Moyen facile d'observer les étoiles doubles avec une grande approximation sans équatorial ni micromètre. L'Astron., 6: 187–191.

MACHE (J.) Nachtrag zu dem Artikel, "Die Auflösbarkeit der Doppelsterne in Fernrohren von verschiedener Grösse." Sirius, 20: 38–44.

MONCK (W. H. S.) Brightness and masses of binary stars. Obsry., 10: 96.

——— Further notes on binary stars. Obsry., 10: 134.

[Prize of the royal Danish academy.] Bull. astron., 4: 164.

TISSERAND (F.) Sur la force qui produit les mouvements des étoiles doubles. Bull. astron., 4: 5–15.

Double stars (Measures of).

DEMBOWSKI (E.) Misure micrometriche . . . 2 v. Roma, 1883, 1884.

Rev. by Schur (W.) Vrtljschr. d. astron. Gesellsch., 22: 209–236.

VON ENGELHARDT (B.) Mikrometrische Beobachtungen von ζ Cancri. Astron. Nachr., 117: 278.

——— Mikrometrische Messungen von Struve'schen weiten Doppelsternen. *Ibid.*, 1–6.

Double stars (Measures of)—*Continued.*

ENGELMANN (R.) Doppelsternmessungen. *Ibid.*, 17–30.

HOUGH (G. W.) Catalogue of 209 new double stars discovered with the 18½-inch refractor of the Dearborn observatory. Astron. Nachr., 116: 273–304. *Also*, Reprint.

JEDRZEJEWICZ (J.) Mesures micrométriques d'étoiles doubles, [1882–86.] Astron. Nachr., 116: 177–186.

LAMP (E.) Über systematische Beobachtungsfehler bei der Bestimmung der Parallaxe der schwächeren Componente des Doppelsterns Σ 2398. Vrtljschr. d. astron. Gesellsch., 22: 342–345.

LEAVENWORTH (F. P.) [Proper motion of Lal. 4219.] Sid. mess., 6: 80.

LEAVENWORTH (F. P.) & MULLER (F.) New double stars discovered at the Leander McCormick observatory. Astron. jour., 7: 95.

RUSSELL (H. C.) Measures of southern double stars made at the observatory, Sydney, N. S. W. Month. not., 47: 473–477.

TARRANT (K. J.) Micrometrical measures of 25 double stars. J. Liverp. astron. soc., 5: 41, 166, 201, 229.

Double stars (Orbits of).

CELORIA (G.) Nuova determinazione dell'orbita della stella doppia Σ 3121. Astron. Nachr., 117: 379.

VON GLASENAPP (S.) Bahn des Doppelsterns δ Equulei. *Ibid.*, 116: 169.

GORE (J. E.) Orbit of 12 Lyncis (Σ 948). *Ibid.*, 117: 290.

——— Orbit of 14 (*i*) Orionis (O. Struve, 98). Month. not., 47: 266.

——— Orbit of Σ 1757. *Ibid.*, 478.

——— Orbit of *p* Eridani. *Ibid.*, 48: 26.

MARTH (A.) Formulæ for correcting approximate elements of the orbits of binary stars. *Ibid.*, 47: 480–494. *Also*, Reprint.

Dresden observatory (Engelhardt's).

VON ENGELHARDT (B.) [Report for 1886.] Vrtljschr. d. astron. Gesellsch., 22: 99.

Dresden observatory (K. math. Salon).

DRECHSLER (A.) [Report for 1886.] *Ibid.*, 100.

Dunecht observatory.

[Report for 1886.] Month. not., 47: 158.

Dunsink observatory.

Astronomical observations and researches . . . Pt. 6. 99 p. 4to. Dublin, 1887. (M. 10.)

[Report for 1886.] Month. not., 47: 153.

Dusseldorf observatory.

LUTHER (R.) [Report for 1886.] Vrtljschr. d. astron. Gesellsch., 22: 102.

Ealing observatory (Common's).

[Report for 1886.] Month. not., 47: 158.

Earth.

ABNEY (W. de W.) Transmission of sunlight through the earth's atmosphere. 33 p. 4to. London, 1887. (M. 1.30.)

ANDERSON (A. A.) Terra: on a hitherto unsuspected second axial rotation of our earth. 8vo. London, 1887. (M. 6.30.)

LOCKYER (J. N.) The movements of the earth. 130 p. 12mo. New York, 1887. ($0.60.)

PARKHURST (H. M.) The earth's temperature. Papers Am. astron. soc., 1: 49–52.

SCHWAHN (P.) Änderungen der Lage der Figur-und der Rotations-Axe der Erde sowie einige mit dem Rotationsproblem in Beziehung stehende geophysiche Probleme. 51 p. 4to. Berlin, 1887. (M. 2.)

WILSING (J.) Mittheilung über die Resultate von Pendelbeobachtungen zur Bestimmung der mittleren Dichtigkeit der Erde. Sitzungsb. d. k. preuss. Akad. d. Wissensch. zu Berlin, 1887: 327–334. *Also*, Reprint. (M. 1.)

Earthquakes.

ALBRECHT (T.) Über eine durch Erdbeben veranlasste Niveaustörung. Astron. Nachr., 116: 129–134.

Easter.

LAKENMACHER (E.) Osterformeln. Astron. Nachr., 116: 325–328; 117: 135.

SCHMIDT (R.) Noch einige Bemerkungen zu den Lakenmacher'schen Osterformeln. *Ibid.*, 117: 51.

SCHRAM (R.) Bemerkungen zu Herrn Lakenmacher's Osterformeln. *Ibid.*, 116: 373–378.

Eclipse of the moon 1887, Aug. 3.

BAUSCHINGER (J.) [Obsn. at Munich.] Astron. Nachr., 118: 122.

C. (M.) [Obsns. at La Tour de Peilz.] Nature, 36: 413.

H. (H.) [Peculiar distortion of earth's shadow observed.] Nature, 36: 367.

JOHNSON (S. J.) Color of eclipsed moon. Obsry., 10: 325.

KLEIN (H. J.) [Obsns. at Cologne.] Sirius, 20: 193.

VON KONKOLY (N.) [Obsns. at O'Gyalla.] *Ibid.*, 235.

LESCARBAULT (E.) Eclipse . . . visible à Orgères. Compt. Rend., 105: 370.

MALET (H. P.) [Obsns. at Killin.] Nature, 36: 413.

RAYET (G.) [Obsns. at Bordeaux.] Compt. Rend., 105: 305.

[Resumé of observations.] il. L'Astron., 6: 348–351.

SCHUR (W.) [Obsns. at Göttingen.] Astron. Nachr., 117: 383.

WEINEK (L.) [Obsns. at Prague.] Astron. Nachr., 117: 381.

Eclipse of the sun 1884, Oct. 4.

KÜSTNER (F.) Bestimmung der Örter der vom Monde wahrend der totalen Finsterniss 1884, Oct. 4, bedeckten Sterne am grossen Meridiankreise zu Berlin. Astron. Nachr., 116: 225–240.

Eclipse of the sun 1886, Aug. 28–29.

JOHNSON (S. J.) [Photographs of partial phase at sea.] Obsry., 10: 224.

Eclipse of the sun 1886, Aug. 28–29—*Continued.*

PERRY (S. J.) Report of the observation . . . at Carriacou. Proc. roy. soc., 47: 316.

PICKERING (W. H.) [Account of his observations.] Science, 10: 9. *Also, abstr.:* Obsry., 10: 306. *Also, abstr.:* Bull. astron., 4: 403.

[SCHUSTER (A.) Preliminary account of observations.] *Abstr.:* Obsry., 10: 203.

STOCKWELL (J. N.) [Obsn. of last contact.] Astron. jour., 7: 3.

T[URNER] (H. H.) [Results of the English expedition to Granada.] Month. not., 47: 175.

Eclipse of the sun 1887, Aug. 18.

ALBRECHT (T.) Die totale Sonnenfinsterniss am 19. August, 1887, nebst Übersicht über die hervorragendsten Sonnenfinsternisse innerhalb Deutschlands im 19. u. 20. Jahrh. 32 p. 8vo. Berlin, 1887. (M. 0.50.)

Darstellung der totalen Sonnenfinsterniss . . . auf carton mit verschiebbarer Mondscheibe. Berlin, 1887. (M. 0.50.)

ENNIS (J.) The total solar eclipse of August next. Sid. mess., 6: 105–109.

FLAMMARION (C.) L'éclipse totale de soleil du 19 août 1887. il. L'Astron., 6: 241–252.

GARNIER (P.) L'éclipse de soleil du 19 août 1887. il. *Ibid.*, 306.

[List of stations and observers.] Obsry., 10: 207.

NIESTEN (L.) [Circumstances, path, etc., of the eclipse.] Ciel et terre, 8: 177.

SCHURIG (R.) Karte der grossen Sonnenfinsterniss am Morgen des 19. Aug., 1887. fol. Leipzig, 1887. (M. 0.40.)

TODD (D. P.) On observations of the eclipse of 1887, Aug. 18, in connection with the electric telegraph. Am. j. sc., 133: 226.

WOEIKOF (A.) [List of stations in Russia desirable for meteorological observations.] Nature, 36; 77.

ZENKER (W.) Sichtbarkeit und Verlauf der totalen Sonnenfinsterniss in Deutschland. 29 p., 1 pl. 8vo. Berlin, 1887. (M. 1.20.)

Eclipse of the sun 1887, Aug. 18. (Observations of.)

ABETTI (A.) at Padua. Astron. Nachr., 117: 279.

ALBRECHT (T.) at Goldap. *Ibid.*, 280.

BELOPOLSKY (A.) at Jurjewetz. *Ibid.*, 118: 45.

DE BOHDANOVITHZ (G.) at Irkoutsk. L'Astron., 6: 425.

COPELAND (R.) & PERRY (S. J.) near Kineshma. Month. not., 48: 48–54.

DUNÉR (N. C.) at Lund. Astron. Nachr., 118: 26.

GALLE (J. G.) [Report of observations at Breslau; also, at Frankfort by Lachmann, and at Kolmar by Körber.] Astron. Nachr., 117: 311.

GARNIER (P.) at Wilna. L'Astron., 6: 354.

GOURDET (P.) L'éclipse et le tremblement de terre en Russie. il. *Ibid.*, 388.

HERZ (N.) at Wien-Ottakring. Astron. Nachr., 118: 26.

JANSSEN (J.) Note sur l'éclipse du 19 août dernier. Compt. Rend., 105: 365.

KONONOWITSCH (A.) at Petrowsk. Astron. Nachr., 118: 24.

Eclipse of the sun 1887, Aug. 18. (Observations of)—*Continued.*

VON KÖVESLIGETHY (R.) at Bromberg. *Ibid.*, 117: 295.

KRÜGER (A.) at Kiel. *Ibid.*, 263.

KÜSTNER (F.) at Berlin. *Ibid.*, 263.

LAMP (E.) at Goldap. *Ibid.*, 263.

LASCHOBER (F.) at Pola. *Ibid.*, 118: 23.

NIESTEN (L.) at Jurjewetz. Ciel et terre, 8: 297, 339. *Also:* L'Astron., 6: 361–364. *Also, transl.:* Sid. mess., 6: 262–265.

OSTI (H.) Die Sonnenfinsterniss am 19. Aug. beobachtet in Upsala. Photographische Aufnahme in 6 verschiedenen Momenten. 1 sheet, 2.5 × 15.5 cm. Upsala, 1887. (M. 1.)

PARSÉHIAN (J.) at Constantinople. L'Astron., 6: 391.

PORRO (F.) at Turin. Astron. Nachr., 117: 279.

[Preliminary reports from various stations.] Nature, 36: 398, 430, 432, 455.

Report of the solar eclipse of 19th August, 1887. Naval observatory in the hydrographic office, Tokio. No. 11. 38 p., 2 pl. 4to. Tokio, 1887.

Japanese characters.

VON SPIESSEN (—) near Berlin. Astron. Nachr., 117: 295.

SUGIYAMA (M.) Photographs taken at Yōmeiji-yama, Echigo, Japan. 1 p. 4to. Tokio [1887].

Summary of observations at various stations.] Sirius, 20: 207, 229, 258.

TODD (D. P.) [Account of the expedition to Japan.] Obsry., 10: 371–376.

TODD (M. L.) The eclipse expedition to Japan. Nation, 45: 137, 169, 229, 554.

URECH (J.) at Elpatievo Narischkine. L'Astron., 6: 353.

WEBER (L.) Photometrische Beobachtungen während der Sonnenfinsterniss 1877, Aug. 18–19 [Breslau]. Astron. Nachr., 118: 17–22.

Eclipses.

Eclipses (Les) du dix-neuvième siècle. il. L'Astron., 6: 252–260.

GINZEL (F. K.) Über einige von persischen und arabischen Schriftstellen erwähnte Sonnen-und Mondfinsternisse. Sitzungsb. d. k. preuss. Akad. d. Wissensch., 1887. *Also*, Reprint. (M. 0.50.)

JOHNSON (S. J.) Notes on a manuscript eclipse volume. Month. not., 47: 430.

Eclipses in England A. D. 538—A. D. 2500.

——— Remarks on the "Canon der Finsternisse." Obsry., 10: 302.

Eclipses of the sun.

EXNER (K.) Über die bei totalen Sonnenfinsternissen auftretenden Erscheinungen der "fliegenden Schatten" und der "Baily's beads" (Perlenreihe). Astron. Nachr., 116: 321.

GINZEL (F. K.) Über die geringsten Phase welche bei der Beobachtung von Sonnenfinsternissen mit freiem Auge noch gesehen werden kann. Astron. Nachr., 118: 119.

——— Über einige historische besonders in altspanischen Gesichtsquellen erwähnte Sonnenfinsternisse. Sitzungsb. d. k. preuss. Akad. d. Wissensch. zu Berlin, 1886: 963-980, 2 pl. *Also*, Reprint. (M. 1.50.)

Eclipses of the sun—*Continued.*

MAHLER (E.) Eine in einer syrischen Grabinschrift erwähnte Sonnenfinsterniss. 8 p. 8vo. Wien, 1887. (M. 0.20.)

Edinburgh observatory.

[Report for 1886.] Month. not., 47: 153.

Ephemerides and almanacs.

Almanaque nautico para el año 1889 . . . 11 + 559 p. 4to. Madrid, 1887.

American ephemeris and nautical almanac for . . . 1890. 1 ed. 6 + 521 + 8 p. 4to. Washington, 1887. ($1.00.)

Annuaire de l'observatoire royal de Bruxelles. Année 55. 1888. 16mo. [Bruxelles, 1887.]

Annuaire pour l'an 1888, publié par le bureau des longitudes. 19 + 808 p. 16mo. [Paris, 1887.] (1 fr. 50 c.)

Annuario del observatorio de La Plata para el año 1887. 424 p. 8vo. Buenos Aires. (M. 8.)

Annuario publicado pelo imperial observatorio do Rio de Janeiro para o anno de 1888. 12mo. Rio Janeiro, 1887.

Anuario del observatorio astronómico nacional de Tacubaya para el año 1888 . . . Año 8. 299 p. 16mo. México, 1887.

Astronomisch-nautische Ephemeriden für das Jahr 1888. Hrsg. von astronomisch-meteorologischen Observatorium der. k. k. Handels und nautischen Akademie in Triest unter Redaction von F. Anton. Jahrg. 1. 88 + 256 p. 8vo. Triest, 1887. (M. 2.70.)

Berliner astronomisches Jahrbuch für 1889. 8 + 495 + 36 + 25 p. 8vo. Berlin, 1887. (M. 12.)

CHARRIER (A.) Effemerdi del sole, della luna et dei principali pianetini . . . per l'anno 1888. 29 p. 8vo. Torino, 1887.

Repr. from: Atti d. r. accad. d. sc. d. Torino, 22.

Companion (Annual) to the Observatory. 55 p. 8vo. London, 1887. (1 *s.* 6 *d.*)

Repr. from: Obsry., 11: 1-55. 1888.

Connaissance des temps pour l'an 1888, publiée par le bureau des longitudes. 5 + 829 + 126 p. 8vo. Paris, 1887.

——— Same. Extrait à l'usage des écoles d'hydrographie et des marins du commerce. 100 p. 8vo. Paris, 1887.

DÖLLEN (W.) Stern-Ephemeriden auf das Jahr 1888 zur Bestimmung von Zeit und Azimut mittelst des tragbaren Durchgangsinstruments im Verticale des Polarsterns. 24 + 27 p. 4to. St. Petersburg, 1887.

DUBOIS (E.) Ephémérides astronomiques et annuaire des marées pour 1888. 12mo. Paris, 1887. (M. 12.)

Ephemerides astronomicas calculadas paro o meridiano do observatorio da universidade de Coimbra . . . para o anno de 1888. 12 + 304 + 16 p. 8vo. Coimbra, 1887.

FLAMMARION (C.) Annuaire astronomique pour 1887. L'Astron., 6: 1-21.

LOEWY (M.) Ephémérides des étoiles de culmination lunaire et de longitude pour 1888. 41 p. 4to. Paris, 1887.

Ephemerides and **almanacs**—*Continued.*

Nautical (The) almanac and astronomical ephemeris for the year 1891. 10 + 514 + 16 p. 8vo. London, 1887. (2*s.* 6*d.*)

Nautisches Jahrbuch oder Ephemeriden und Tafeln für das Jahr 1890 zur Bestimmung der Zeit, Länge und Breite zur See nach astronomischen Beobachtungen. Hrsg. von Reichsamt des Innern. Berlin, 1887. (M. 1.50)

Equatorial. *See, also,* Illumination.

Wolf (M.) Einfache Methode den Gang eines Triebwerks zu prüfen. Astron. Nachr., 116: 117.

Errors. *See* Observations (Errors of).

Eudoxus.

Ars astronomica, qualis in charta ægyptica superest. Denuo edita a F. Blass. 25 p. 4to. Kiliae, 1887. (M. 1.)

Faculæ. *See, also,* Sun (Statistics of faculæ, prominences, spots, etc., for 1886).

Mascari (A.) Latitudine eliografiche e frequenza dei gruppi di facole brillanti durante il sessennio 1881–1886. Mem. soc. spettrscp. ital., 16: 80–85.

Measures of positions and areas of spots and faculæ . . . on photographs taken . . . at Greenwich, in India, and in the Mauritius. Greenw. spectrscp. obsns. 1885: 34–104.

Tacchini (P.) Facole solari osservate al regio osservatorio del collegio Romano nel 1886. Mem. soc. spettrscp. ital., 16: 4–7.

——— Observations solaires du deuxième semestre 1886. Compt. Rend., 104: 216.

——— Osservazioni di macchie e facole solari. [4° trimestre, 1886.] Atti d. r. accad. d. Lincei, s. 4. Rendic., 3: 14.

——— Same. 1° trimestre, 1887. *Ibid.*, 265.

——— Observations solaires faites à Rome pendant le premier trimestre de l'année 1887. Compt. Rend., 104: 1082; 105: 210.

——— Same. 2° trimestre. *Ibid.*, 105: 211.

——— Same. 3° trimestre. *Ibid.*, 1002.

——— Macchie e facole solari osservate al regio osservatorio del collegio Romano nel 1° trimestre del 1887. Mem. soc. spettrscp. ital., 16: 33–36, 54–57.

——— Same. 2° trimestre. *Ibid.*, 87–90.

——— Same. 3° trimestre. *Ibid.*, 118.

Feil (Charles).

For Obituary, *see* L'Astron., 6: 392. *Also:* Nature, 35: 306

Pellöcker (Siegmund) [1816?–1887].

Wagner (—) Todes-Anzeige. Astron. Nachr., 117: 391.

Flexure.

Schaeberle (J. M.) Horizontal flexure of vertical circles. Astron. Nachr., 118: 147–152.

——— Method for measuring the astronomical flexure in zenith distance for all positions of the instrument. *Ibid.*, 147.

Fraunhofer (Joseph) [1787–1826].

Bauernfeind (C. M.) Gedächtnissrede auf J. von Fraunhofer zur Feier seines 100 Geburtstages. 30 p. 4to. München, 1887. (M. 0.80.)

Fraunhofer (Joseph) [1787-1826]—*Continued.*

Festbericht über die Gedenkfeier zur hundertjährigen Wiederkehr des Geburtstages Josef Fraunhofer's am 6. März, 1887, im Berliner Rathhause. Ztschr. f. Instrmknd., 7: 114-128. [Portrait.]

Voit (—) [Biographical notice.] 20 p., portr. 8vo. München, 1887. (M. 1.50.)

See, also, Obsry., 10: 239. *Also:* Sirius, 20: 49-54, 113.

Geneva observatory.

Gautier (E.) [Report for 1886.] Vrtljschr. d. astron. Gesellsch., 22: 102.

Rapport sur le concours pour le réglage des chronomètres pendant l'année 1886 . . . par E. Gautier. [11] p. 8vo. [n. p., 1887.]

Glass (Optical). *See, also,* Objectives.

Dallinger (W. H.) Value of the new apochromatic lenses. *Abstr.:* Nature, 35: 467.

Gill (D.) [Remarks on the new optical glass.] Obsry., 10: 214. *Also, abstr.:* Bull. astron., 4: 301.

Nielsen (V.) Schott and Abbé's new optical glass. Eng. mec., 44: 564. *See, also, Ibid.*, 563.

Tornow (E.) Relative Preise der Rohglasplatten für Fernrohr-objective nebst einem Vorschlage zu deren systematischer Normirung. il. Ztschr. f. Instrmknd., 7: 247.

Gotha observatory.

Becker (E.) [Report for 1886.] Vrtljschr. d. astron. Gesellsch., 22: 110.

Göttingen observatory.

Schur (W.) Festlegung des südlichen Endpunktes der Gauss'schen Gradmessung auf der Sternwarte in Göttingen. Astron. Nachr., 118: 94.

—— [Report for 1886.] Vrtljschr. d. astron. Gesellsch., 22: 104-109.

Gravitation. *See, also,* Mechanics (Celestial); Planets.

Rethwisch (E.) Die Bewegung im Weltenraum. Kritik der Schwerkraft und Analyse der Axendrehung. 146 p. 8vo. Berlin, 1887. (M. 4.50.)

Sterneck (R.) Untersuchungen über die Schwere im Innern der Erde. Mittheil. d. k. k. militar-geogr. Inst. Wien, 1886.

Rev.: Bull. astron., 4: 234.

Greenwich observatory.

Astronomical and magnetical and meteorological observations made at the royal observatory, Greenwich, in the year 1885, under the direction of W. H. M. Christie. [965] p. 4to. London, 1887. (M. 22.)

[Report for 1886.] Month. not., 47: 148-151.

Report of the astronomer royal . . . 4to. [London, 1887.]

Turner (H. H.) Variations of level and azimuth of the transit circle. Month. not., 47: 325-333.

Grignon observatory.

Lamey (F. M.) [Report for 1886.] Vrtljschr. d. astron. Gesellsch., 22: 111-115.

Harrow observatory (Tupman's).

[Report for 1886.] Month. not., 47: 161.

Harvard college observatory.

Annals . . . vol. 17. The almucantar: an investigation made at the observatory in 1884 and 1885, by S. C. Chandler, jr. 9 + 222 p., 1 pl. 4to. Cambridge, 1887. (M. 18.)

Annals . . . vol. 18, [nos. 1 and 2.] 27 p. 4to. [Cambridge, 1887.]

No. 1: Magnitudes of stars employed in various nautical almanacs. No. 2: Discussion of the Uranometria Oxoniensis.

Boyden fund [circular no. 1]. 3 p. 4to. [Cambridge, 1887.]

——— Same. No. 2. Meteorological observations. 6 p. 4to. [Cambridge, 1887.]

Boyden fund and preliminary experiments in Colorado. Sc. Am. sup., 9715.

[Description of the instruments and of the methods of astronomical photography at Harvard college observatory.] il. Sc. Am., 57: 289, 278.

Draper (Henry) memorial. First annual report of the photographic study of stellar spectra . . . [by] E. C. Pickering. 10 p., 1 pl. Cambridge, 1887.

Also: Mem. soc. spettrscp. ital., 16: 93–98. *Also, Rev.:* Obsry., 10: 231. *Also:* Nature, 36: 31, 41.

Report (42d Annual) of the director . . . E. C. Pickering . . . Dec. 2, 1887. 12 p. 8vo. Cambridge, 1887.

Helsingfors observatory.

Donner (A.) [Report for 1886.] Vrtljschr. d. astron. Gesellsch., 22: 115–117

Herény observatory.

von Gothard (E.) [Report for 1886.] *Ibid.*, 118–120.

Herschel (Sir William) [1738–1822].

Chambers (G. F.) [Note concerning his life at Bath.] Obsry., 10: 166.

Hong Kong observatory.

[Report for 1886.] Month. not., 47: 171.

Illumination.

Dreyer (J. L. E.) Electric illumination of the Armagh refractor. Month. not., 47: 117.

Stone (O.) Telescopic illumination. [Electric.] Sid. mess., 6: 73.

Instruments. *See* Chronometers; Clocks; Circle-divisions; Equatorial; Illumination; Objectives.

Interpolation.

Radau (R.) Sur un problème d'interpolation. Bull. astron., 4: 515–519.

Thiele (T. N.) Ausgleichung und Interpolation von Zeitbestimmung. Vrtljschr. d. astron. Gesellsch., 22: 302–313.

Weyer (G. D. E.) Interpolation bei periodischen Functionen. *Ibid.*, 292.

——— Interpolation für die Mitte bei periodischen Functionen. Astron. Nachr., 117: 313–322.

Iowa college observatory.

[New observatory at Grinnell, Iowa.] Sid. mess., 6: 322.

Journals (Astronomical).

Astronomical (The) journal. Edited by B. A. Gould, Cambridge, Mass. [Semi-monthly.] v. 7. 4to. Boston. ($5.00.)

L'Astronomie. Revue d'astronomie populaire . . . publiée par C. Flammarion. [Monthly.] 6. Année, 1887. 488 p. 4to. Paris, 1886. (14 fr.)

Astronomische Nachrichten. Hrsg von A. Krüger. Bd. 116 [Nr. 2761–2784]. 7 + 402 p. 4to. Kiel, 1887. (M. 15.)

——— Same. Bd. 117 [Nr. 2785–2808]. 7 + 407 p. 4to. Kiel, 1887. (M. 15.)

Bulletin astronomique, publiée sous les auspices de l'observatoire de Paris par F. Tisserand [*and others*]. [Monthly.] Tome 4, 1887. 557 p. 8vo. Paris, 1887.

Bulletin des sciences mathématiques et astronomiques. Rédigée par Darboux, Houel, et Tannery. Année 1887. Serie 2. Tome 11. 8vo. Paris, 1887. (M. 18.)

Ciel et terre. Revue populaire d'astronomie de météorologie et de physique du globe. [Semi-monthly.] 2. serie, 2. année (7. année de la collection). 8vo. Bruxelles, 1887.

Memorie della società degli spettroscopisti italiani, raccolte et pubblicate . . . P. Tacchini. 6 + 220 p. 4to. Roma, 1888.

Monthly notices of the royal astronomical society . . . Nov., 1886, to Nov., 1887. Vol. 47. 8vo. London, 1887.

Observatory (The); a monthly review of astronomy. Edited by E. W. Maunder, A. M. W. Downing, and T. Lewis. Vol. 10. 7 + 440 p. 8vo. London, 1887. (14*s*.)

Revista do observatorio. Publicação mensal do imperial observatorio do Rio de Janeiro. Anno 2, 1887. Red. L. Cruls [*and others*]. 8 + 198 p. 4to. Rio de Janeiro, 1887.

Sidereal (The) messenger; a monthly review of astronomy. Conducted by W. W. Payne. Vol. 6. 368 p. 8vo. Northfield, 1887. ($2.00.)

Sirius. Zeitschrift für populäre Astronomie . . . Hrsg. von H. J. Klein. [Monthly.] 20 Bd. oder n. F. 15 Bd. 288 p. 8vo. Leipzig, 1887. (M. 10.)

Vierteljahrsschrift der astronomischen Gesellschaft. Hrsg. von . . . E. Schönfeld und H. Seeliger. 22. Jahrgang. 7 + 417 p., 2 pl., portrs. 8vo. Leipzig, 1887. (M. 8.)

Wochenschrift fur Astronomie, Meteorologie und Geographie. Hrsg. von H. J. Klein. Jahrgang 30. 8vo. Halle, 1887. (M. 10.)

Jupiter.

Denning (W. F.) La tache rougeâtre de Jupiter. il. L'Astron., 6: 330.

——— Motion of Jupiter's red spot. Obsry., 10: 229.

Lamey (F. M.) Périodicité moyenne des taches de Jupiter. Compt. Rend., 104; 279. *See*, *also*, *Ibid.*, 618.

Lynn (W. T.) [Rotation time.] Obsry., 10: 431.

Marth (A.) Ephemeris for physical observations of Jupiter, 1888. Month. not., 48: 68–76. *Also*, Reprint.

Noble (W.) Engraving (An old) of Jupiter. Month. not., 47: 515.

Jupiter—*Continued.*

TARRANT (K. J.) *and others.* [Observations of Jupiter, 1885–86.] J. Liverp. astron. soc., 5: 63–66.

TEBBUTT (J.) [Near approach to Lal. 25797, 1887, Apr. 21.] Obsry., 10: 273.

TERBY (F.) Tache rouge de Jupiter. Obsry., 10: 107.

——— [Obsn. of red spot, 1887, May 10.] *Ibid.*, 231.

WILLIAMS (A. S.) [Obsn. of red spot, 1886, Dec. 20.] *Ibid.*, 71.

——— [Motion of red spot from obsns. 1886, Dec. 20, to 1887, Apr. 21.] *Ibid.*, 193.

Jupiter (Satellites of).

BACKLUND (O.) Sur la théorie des satellites de Jupiter. Bull. astron., 4: 321–339.

BALL (R. S.) Notes on Laplace's analytical theory of the perturbations of Jupiter's satellites. Proc. roy. Irish acad., 2 s., 4: 557–567. 1886.

SOUILLART (—) Théorie analytique des mouvements des satellites de Jupiter. Partie 2. Réduction des formules en nombres. 200 p. 4to. Paris, 1887. (M. 12.)

SPITTA (E. J.) Appearances presented by the satellites of Jupiter during transit, with a photometric estimation of their relative albedos, and of the amount of light reflected from the different portions of an unpolished sphere. Month. not., 48: 32–48.

TROUVELOT (E. L.) Duplicité de l'ombre du premier satellite . . . il. L'Astron., 6: 414.

Juvisy observatory.

[Description of the observatory and instruments.] il. L'Astron., 6: 321–330.

Kew observatory.

[Report for 1886.] Month. not., 47: 154.

Kiel observatory.

KRÜGER (A.) [Report for 1886.] Vrtljschr. d. astron. Gesellsch., 22: 120–122.

Kirchhoff (Gustav Robert) [1824–1887].

TAIT (P. G.) [Biographical sketch.] Nature, 36: 606.

VOGEL (H. C.) Todes-Anzeige. Astron. Nachr., 118: 47.

Kis Kartal observatory.

VON KÖVESLIGETHY (R.) Sternwarte des Baron Geiza von Podmaniczky in Kis Kartal, Ungarn. il. Sirius, 20: 145.

Kremsmünster observatory.

WAGNER (C.) [Report for 1886.] Vrtljschr. d. astron. Gesellsch., 22: 122.

Latitude.

FLINT (A. S.) Most probable value of the latitude, and its theoretical weight from entangled observations occurring in the use of Talcott's method. Ann. math., 3: 172–185. *Also,* Reprint.

Least squares. *See, also,* Latitude; Observations (Errors of).

GAUSS (C. F.) Abhandlungen zur Methode der kleinsten Quadrate. In deutscher Sprache hrsg. von A. Börsch und P. Simon. Berlin, 1887.

Leipzig observatory.

BRUNS (H.) [Report for 1886.] Vrtljschr. d. astron. Gesellsch., 22: 123.

Leipzig observatory (Engelmann's).

ENGELMANN (R.) [Report for 1886.] *Ibid.*, 124.

Lenses. *See* Glass (Optical); Photography (Astronomical); Spherometer.

Lick observatory.

APPEL (D.) Der grosse Refraktor der Lick-Sternwarte. Sirius, 20: 54.

[Description of instruments, progress of work, etc.] Eng. mec., 44: 149, 474, 519; 46: 321. *Also:* Nation, 44: 233; 45: 506. *Also:* Obsry., 10: 110, 168. *Also:* Sc. Am., 57: 330. *Also:* Sid. mess., 6: 86, 87, 157, 295. *Also:* Sirius, 20. 285.

KEELER (J. E.) Time service of the Lick observatory. 16 p. 8vo. [Northfield, 1887.]

Repr. from: Sid. mess., 6: 233-248.

PROCTOR (R. A.) The great Lick telescope. Knowl., 10: 205, 209.

Publications of the Lick observatory of the university of California . . . by E. S. Holden. Vol. 1, 1887. 3 + 312 p. il. 4to. Sacramento, 1887.

TODD (D. P.) [Lecture on] the Lick observatory. Sc. Am., 56: 73.

Liége observatory (Ougrée).

DE BALL (L.) [Report for 1886.] Vrtljschr. d. astron. Gesellsch., 22: 125.

Light. *See, also,* Earth; Sky-glows; Spectrum analysis.

BELL (L.) Absolute wave-length of light. Am. j. sc., 133: 167–182.

MICHELSON (A. A.) Velocity of light in air and refracting media. Sc. Am. sup. 9331.

MICHELSON (A. A.) & MORLEY (E. W.) Relative motion of the earth and the luminiferous æther. Am. j. sc., 134: 333–345.

——— Method of making the wave-length of sodium light the actual and practical standard of length. *Ibid.*, 427–430.

Liverpool observatory.

[Report for 1886.] Month. not., 47: 155.

Louvain observatory (Terby's).

PAUWELS (C.) L'observatoire particulier de M. F. Terby à Louvain. Ciel et terre, 8: 13–16.

Lunar theory.

AIRY (G. B.) Numerical lunar theory. 10 + 178 p. 4to. London, 1886. (15 *s.*)

Rev. by R[adau] (R.) Bull. astron., 4: 275-286. *Also:* Obsry., 10: 339, 377. *See, also,* Obsry., 10: 175.

COLBERT (E.) Motion of the lunar apsides. Sid. mess., 6: 49, 82.

GLAISHER (J. W. L.) Address . . . on presenting the gold medal of the [royal astronomical] society to G. W. Hill. Month. not., 47: 203, 220.

HALL (A.) Note on Mr. Stockwell's "Analytical determination of the inequalities in the motion of the moon arising from the oblateness of the earth." Astron. jour., 7: 41.

NEISON (E.) On G. W. Hill's paper on Delaunay's method. Month. not., 47: 517.

Lunar theory—*Continued.*

Radau (R.) Remarques complémentaires relatives à la théorie de la lune. Bull. astron., 4 : 383.

Stockwell (J. N.) Inequalities in the moon's motion produced by the oblateness of the earth. Astron. jour., 7 : 4, 17, 25, 35.

——— Certain inequalities in the moon's motion arising from the action of the planets. *Ibid.*, 105, 113.

——— Inequalities of long period in the moon's motion arising from the action of Venus. *Ibid.*, 145–150.

Stone (E. J.) Observations of the moon made at the Radcliffe observatory, 1886, and comparison of the results with the tabular places from Hansen's lunar tables. Month. not., 47 : 79–85.

Lund observatory.

[Report for 1886.] Vrtljschr. d. astron. Gesellsch., 22 : 127.

Luther (Eduard) [1816–1887].

Franz (J.) Todes-Anzeige. Astron. Nachr., 118 : 31.

Lyme Regis observatory (Peek's).

[Report for 1886.] Month. not., 47 : 160.

McCormick observatory.

Report of the director . . . for the year ending June 1, 1887. 4 p. 4to. [n. p., n. d.]

Maresfield observatory (Noble's).

Noble (W.) Latitude and longitude of Maresfield observatory. Month. not., 48 : 67.

Mars.

Lohse (J. G.) [Observations 1886, Apr. 23, 26.] Month. not., 47 : 496.

Marth (A.) Ephemeris for physical observations of Mars. *Ibid.*, 48 : 78–88. *Also*, Reprint.

Meunier (S.) Recent phenomena on the surface of Mars. il. Sc. Am. sup. 9384. *Also:* Pop. sc. month., 31 : 532–534.

Poretzki (P.) Mars-opposition im Jahre 1877 beobachtet . . . zu Kasan. Astron. Nachr., 116 : 241–246.

——— Same. 1879. *Ibid.*, 369.

——— Same. 1886. *Ibid.*, 187.

Mars (Satellites of).

Morrison (J.) Ephemerides of the satellites of Mars during the oppositions of 1888 and 1890. Month. not., 47 : 439–442.

Mechanics (Celestial). *See, also,* Gravitation; Lunar theory; Orbits; Perturbations; Planets.

Bruhns (H.) Über die integrale des Vielkörper-Problems. Ber. u. d. Verhandl. d. k. säch. Gesellsch. d. Wissensch. zu Leipz. Math.-phys. Cl., 93 : 1, 55.

Callandreau (O.) Sur le calcul des integrales . . . Bull. astron., 4 : 192.

Hall (A.) Special case of the Laplace coefficients $b_s^{(i)}$. Ann. math., 3 : 1–11.

Mechanics (Celestial)—*Continued.*

HILL (G. W.) Coplanar motion of two planets, one having a zero mass. Ann. math., 3: 65–73. *Also*, Reprint.

——— Differential equations with periodic integrals. Ann. math., 3: 145–153.

JOUKOVSKY (N. E.) [Sur le mouvement d'un corps solide qui a des lacunes remplies par un liquide homogène.] 8vo. St. Pétersbourg, 1885.

Rev.: Bull. astron., 4: 429.

LANGE (L.) Die geschichtliche Entwickelung des Bewegungsbegriffes. 10 + 141 p. 8vo. Leipzig, 1886.

Rev. by Seeliger (H.) Vrtljschr. d. astron. Gesellsch., 22: 252–259.

——— Über das Beharrungsgesetz. Ber. u. d. Verhandl. d. k. sächs Gesellsch. d. Wissensch. zu Leipzig. Math.-phys. Kl., 1885: 333–351.

Rev. by Seeliger (H.) Vrtljschr. d. astron. Gesellsch., 22: 252–259.

TISSERAND (F.) Note sur un passage de la "Mécanique céleste." Bull. astron., 4: 457–462.

Melbourne observatory.

Report (22nd) of the board of visitors . . . with the annual report of the government astronomer. 12 p. 4to. Melbourne, [1887.]

Meteors. *See, also*, Comets and meteors.

DENNING (W. F.) Determination of meteor-paths and radiants. Obsry., 10: 358.

[HIRN (—)] Explosion of meteorites. *Abstr.:* Nature, 35: 303.

KIRKWOOD (D.) Relation of aerolites to shooting stars. Sid. mess., 6: 248.

KLEIBER (J.) Les étoiles filantes et la température. Ciel et terre, 7: 561–570.

LAGRANGE (E.) L'origine des météorites. *Ibid.*, 8: 81–92.

LOCKYER (J. N.) Researches on the spectra of meteorites. Proc. roy. astron. soc., 43: 117–155.

——— Recherches sur les météorites. Conclusions générales. Compt. Rend., 105: 997–1001.

MONCK (W. H. S.) Meteors and meteorites. J. Liverp. astron. soc., 5: 110, 140.

PRINZ (W.) L'origine des météorites. Ciel et terre, 8: 133–137.

Meteors (Observations of).

DENNING (W. F.) Meteors with curved paths. Month. not., 47: 119

——— [Observations of April meteors.] Nature, 35: 606.

——— The meteor of May 8, 1887. *Ibid.*, 36: 68.

——— August meteors of 1887. *Ibid.*, 407.

——— October meteor shower of 1887. *Ibid.*, 37: 69.

——— Meteor notes. Obsry., 10: 65, 102, 129, 159, 188, 227, 265, 299, 313, 351, 384, 417.

——— [Observations 1886, Nov. 17—Jan. 25.] Sid. mess., 6: 160.

——— [Observations 1887, Mar. 13—July 31.] *Ibid.*, 287.

——— Recent showers [1887, Aug. 6—Oct. 21.] *Ibid.*, 356

Meteors (Observations of)—*Continued.*

DENNING (W. F.) & *others.* [Observations during Jan., Feb., and Mar., 1887.] J. Liverp. soc., 5: 193–196.

——— [Observations 1887, Apr. 5.] *Ibid.*, 228.

HALL (A.) [Observations of] the Perseids, 1887. Astron. jour., 7: 126.

HOPKINS (B. J.) Note on an erratic meteor. Month. not., 47: 73.

KIRK (E. B.) [Two meteors 1887, Jan. 13.] Obsry., 10: 107.

LASCHOBER (F.) Sternschnuppenfälle am 10. und 11. Aug., 1885. Astron. Nachr., 118: 33–40.

——— Beobachtung der Sternschnuppenfälle am 10. und 11. Aug., 1887. *Ibid.*, 39.

RANYARD (A. C.) Evidence with respect to the form of the area in the heavens from which the meteors of Nov. 27, 1885, appeared to radiate. Month. not., 47: 69–73.

Remarkable (A) meteor. Nature, 36: 93.

Meudon observatory.

JANSSEN (J.) Note sur les travaux récents exécutés à l'observatoire de Meudon. Compt. Rend., 105: 325–328.

Milan observatory.

SCHIAPARELLI (G. V.) [Report for 1886.] Vrtljschr. d. astron. Gesellsch., 22: 127–131.

Monrepos observatory (von Lade's).

WOLF (M.) Privatsternwarte Monrepos bei Geisenheim. 1 pl. Sirius, 20: 217.

Moon. *See, also,* Eclipse of the moon; Lunar theory.

ELGER (T. G.) The moon surveyed in common telescopes. J. Liverp. astron. soc., 5: 18, 124, 155, 179, 212.

——— Selenographical notes. Obsry., 10: 67, 100, 127, 157, 187, 226, 263, 298, 316, 354, 386, 419.

ELGER (T. G.) & *others.* [Observations of lunar objects 1886–87.] J. Liverp. astron. soc., 5: 16, 60, 116, 221.

F[LAMMARION] (C.) Grande vallée des Alpes lunaires. il. L'Astron., 6: 448–452.

GAUDIBERT (C. M.) Carte générale de la lune dressée sous la direction de C. Flammarion. Paris, 1887. (7 fr.)

HOUZEAU (J. C.) [Influence de la lune sur les éléments météorologiques.] Ciel et terre, 8: 369–376.

MONCK (W. H. S.) Effect of terrestrial heat on the moon. J. Liverp. astron. soc., 5: 52.

Moon (The) and the weather. Eng. mec., 45: 187.

SPITALER (R.) Mondphotographie. Sirius, 20: 75, 101.

WILLIAMS (A. S.) Account of further observations of the lunar crater Plato. Obsry., 10: 59, 345–351.

Morrison observatory.

Publications of the Morrison observatory, Glasgow, Missouri. No. 1 . . . by Carr Waller Pritchett. 1885. 7 + 111 p., 6 pl. 4to. Lynn, 1887.

Munich observatory.

Seeliger (H.) [Report for 1886.] Vrtljschr. d. astron. Gesellsch., 22: 131-135.

Natal observatory.

Report of the superintendent, 1886. 26 p. 4to. [n. p., 1887.]

Navigation. *See, also,* Astronomy (Spherical and practical); Sextant.

Caillau (T.) Instrument servant à la determination de la position du navire par deux relèvements d'un même point et l'intervalles, et des problèmes qui s'y rattachent. il. Rev. d. obsrio., 2: 138-41.

Types de calculs nautiques. Navigation par l'estime et navigation astronomique. fol. Paris, 1887. (M. 6.50.)

Nebulæ. *See, also,* Nova Andromedæ.

Bigourdan (G.) Nébuleuses nouvelles découvertes à l'observatoire de Paris. Compt. Rend., 105: 926, 1116.

Dreyer (J. L. E.) Some nebulæ hitherto suspected of variability or proper motion. Month. not., 47: 412-421.

von Engelhardt (B.) Relative E. B. des Nebels G. C. 3258 gegen einen benachbarten Stern 11. Grösse. Astron. Nachr., 117: 278.

Harrington (M. W.) Structure of 13 M. Herculis. il. Astron. jour., 7: 156.

Ingall (H.) Notes on nebulæ. il. Eng. mec., 46: 318.

Johnson (R. C.) Photography and 42 M. Obsry., 10: 99.

Leavenworth (F. P.) [Notes on nebulæ.] Sid. mess., 6: 293.

Lynn (W. T.) First discovery of the great nebula in Orion. Obsry., 10: 232.

Millosevich (E.) & Barnard (E. E.) Über Nr. 14 und 15 des Swift'schen Nebelcatalogs Nr. 6. Astron. Nachr., 118: 173.

Mouchez (E.) Photographie de la nébuleuse 1180 du catalogue général d'Herschel par MM. Paul et Prosper Henry. Compt. Rend., 104: 394.

Muller (F.) [Errata in Swift's catalogue no. 5.] Sid. mess., 6: 83.

——— Corrections to catalogue no. 6 of new nebulæ discovered at the Warner observatory. *Ibid.*, 323

——— [Method of observing nebulæ at the McCormick observatory.] *Ibid.*, 361.

Roberts (I.) Photographs of nebulæ in Orion and in the Pleiades. Month. not., 47: 89-91.

——— Photographs of the nebulæ 57 M. Lyræ, 27 M. Vulpeculæ, the cluster 13 M. Herculis, and of stars in Cygnus. *Ibid.*, 48: 29-31.

Spitaler (R.) Über den Ringnebel in der Leyer. Astron. Nachr., 117: 261.

Struve (O.) La nébuleuse près de *c* Orionis. 1 pl. Bull. d. l'acad. imp. d. sc. d. St. Pétersb., 31: 540-544.

Swift (L.) Catalogue no. 6 of nebulæ discovered at the Warner observatory. Astron. Nachr., 117: 217-222.

Nebular hypothesis. *See, also,* Cosmogony.

BIGELOW (F. H.) The phenomena of cooling envelopes. Sid. mess., 6 : 170-175.

KERZ (F.) Weitere Ausbildung der Laplace'schen Nebularhypothese. 2. Ausgabe der "Erinnerungen an Satze aus der Physik und der Mechanik des Himmels." 16 + 384 p. 8vo. Leipzig, 1886. (M. 12.)

——— Über die Entstehung der Körper welche sich um die Sonne bewegen. Auch als Nachtrag zu, "Weitere Ausbildung der Laplace'schen Nebularhypothese. 8 + 79 p. 8vo. Leipzig, 1887. (M. 1.80.)

——— Beitrag zur Nebularhypothese. Sirius, 20 : 265.

Neptune (Satellite of).

LOHSE (J. G.) [Observations 1885, Dec. 2—1886, Nov. 4.] Month. not., 47 : 497.

PERROTIN (J.) [Observations 1886, Nov. 22—1887, Jan. 23.] Bull. astron. 4 : 341.

Neuchâtel observatory.

Rapport du directeur . . . 1886. 27 + 28 + 12 p. 12mo. Locle, 1887.

Nice observatory.

Annales de l'observatoire de Nice, publiées sous les auspices du Bureau des longitudes, par [J.] Perrotin. Tome II. [431] p., 7 pl. 4to. Paris, 1887. (M. 25.)

FAYE (H.) Note sur les premiers travaux de l'observatoire de Nice. Compt. Rend., 105 : 7-10.

——— [Inauguration de l'observatoire de Nice.] *Ibid.*, 780-784.

Nova Andromedæ nebulæ, 1885.

BALL (R. S.) [Observations for parallax.] Proc. roy. Irish acad., 2. s. 4 : 641.

COPELAND (R.) On Hartwig's Nova Andromedæ. [Complete series of observations.] Month. not., 47 : 49-61.

FRANZ (J.) [Parallaxenbestimmung.] Astron. Nachr., 118 : 123.

Nutation.

FOLIE (F.) Nutation diurne du globe terrestre. Compt. Rend., 104, 35-38.

——— Praktischer Beweis der täglichen Nutation. Astron. Nachr., 116 : 113.

——— Über einige in den Peters'schen Formeln unberücksichtigte Glieder der jährlichen Nutation. *Ibid.*, 167.

——— Stündliche Nutation der Erdkruste. Vrtljschr. d. astron. Gesellsch., 22 : 320-323.

LAGRANGE (C.). Nutation diurne. Ciel et terre, 7 : 489-494

Objectives. *See, also,* Glass (Optical); Telescopes.

GRUBB (H.) & *others.* [Transforming an ordinary object-glass into a photographic objective.] Obsry., 10 : 253-256.

MOSER (C.) Fernrohrobjective. Ztschr. f. Instrmknd., 7 : 225-238, 308-323.

PICKERING (E. C.) New form of construction of object-glasses intended for stellar photography. Nature, 36 : 562.

TAYLOR (J. T.) Photographic lenses. Eng. mec., 44 : 495, 517

Observations (Errors of). *See, also,* Latitude; Transit observations.

BERTRAND (J.) Sur une loi singulière de probabilité des erreurs. Compt. Rend., 105: 779.

——— Théorème relatif aux erreurs d'observation. *Ibid.*, 1043.

——— Sur ce qu'on nomme le poids et la précision d'une observation. *Ibid.*, 1099–1102.

——— Sur la loi des erreurs d'observation. *Ibid.*, 1147.

——— Sur les épreuves répétées. *Ibid.*, 1201.

HALL (A.) Rejection of discordant observations. Sid. mess., 6: 297–301. *Also:* Obsry., 10: 414–417.

LEHMANN-FILHÉS (R.) Über abnorme Fehlervertheilung und Verwerfung zweifelhafter Beobachtungen. Astron. Nachr., 117: 121–132.

STADTHAGEN (E.) Zur zweiten Grundannahme der Fehlertheorie von Laplace. Astron. Nachr., 118: 27.

Observatories.

LANCASTER (A.) Liste générale des observatories et des astronomes, des sociétés et des revues astronomiques. 2. ed. 114 p. 12mo. Bruxelles, 1887.

LOEWY (M.) Rapport sur les observatoires de Province. 33 p. 8vo. Paris, 1887.

O'Gyalla observatory.

Beobachtungen augestellt am astrophysikalischen Observatorium in O'Gyalla. Hrsg. von N. von Konkoly. Bd. 8. Theil. 1. Beobachtungen vom Jahre 1885. 68 p. 4to. Halle, 1887. (M. 6.50.)

——— Same. Theil 2. 5 + 41 p. 4to. Halle, 1887. (M. 4.)

VON KONKOLY (N.) Mittheilungen der Sternwarte zu O'Gyalla. Sirius, 20: 156, 169.

——— [Report for 1886.] Vrtljschr. d. astron. Gesellsch., 22: 135–138.

von Oppolzer (Theodor) [1841–1886].

LOEWY (M.) Notice sur la vie et les travaux de M. Oppolzer. Bull. astron., 4: 42–48.

[Obituary discourse, Vienna academy; with bibliography.] Obsry., 10: 309–313.

PASQUIER (E.) [Biographical notice.] Ciel et terre, 7: 546–549.

SCHRAM (R.) [Biographical notice, with bibliography and portrait.] Vrtljschr. d. astron. Gesellsch., 22: 117–208, 266.

TISSERAND (F.) Notice sur les travaux de M. Oppolzer. Compt. Rend., 104: 108.

WEISS (E.) Nekrolog über Theodor von Oppolzer. Astron. Nachr., 116: 95.

Orbits.

ANDOYER (H.) Remarques sur les équations différentielles que l'on rencontre dans la théorie des orbites intermédiares. Bull. astron., 4: 177–183.

GYLDÉN (H.) Determination of the radius vector in the absolute orbit of the planets. Month. not., 47: 223–244.

Orbits—*Continued.*

HERZ (N.) Geschichte der Bahnbestimmung von Planeten und Cometen. I Theil. Die Theorien des Alterthums. 8vo. Leipzig, 1887. (M. 5.)

KLINKERFUES (W.) Bestimmung der mittleren Anomalie in Ellipsen und Hyperbeln deren Excentricität der Einheit sehr nahe kommt. Astron. Nachr., **118** : 165–172.

RADAU (R.) Calcul d'une orbite parabolique. Bull. astron., 4 : 409–422.

——— Formules différentielles pour la variation des éléments d'une orbite. Compt. Rend., 105 : 482–485.

——— Calcul approximatif d'une orbite parabolique. *Ibid.*, 457–460.

RUSH (H. G.) The true doctrine of orbits: an original treatise on central forces. 7 + 133 p. 8vo. Lancaster, Pa., 1887.

SEARLE (G. M.) Method of computing an orbit from three observations. Astron. jour., 7 : 140–144, 153–155.

Orwell Park observatory (Tomline's).

[Report for 1886.] Month. not., 47 : 161.

Oxford university observatory.

[Report for 1886.] *Ibid.*, 156.

Palermo observatory.

Pubblicazioni del real osservatorio di Palermo. Anni 1883–85, vol. 3. G. Cacciatore, direttore. 420 p. 4to. Palermo, 1887.

CACCIATORE (G.) [Report for 1886.] Vrtljschr. d. astron. Gesellsch., 22 : 138–140.

Parallax (Solar). *See, also*, Venus (Transit of).

CRULS (L.) Valeur de la parallaxe du soleil déduite des observations des missions brésiliennes, à l'occasion du passage de Vénus sur le soleil en 1882. Compt. Rend., 105 : 1235–1237.

OBRECHT (J. A.) Sur une nouvelle méthode permettant de déterminer la parallaxe du soleil à l'aide de l'observation photographique du passage de Vénus. *Ibid.*, 104 : 560–563.

Parallax (Stellar). *See, also*, Nova Andromedæ.

DE BALL (L.) Détermination de la parallaxe relative de l'étoile principale du couple optique Σ 1516 A B. 38 p. 4to. Bruxelles, 1887. (M. 2.)

HALL (A.) Parallax of α Tauri. Astron. jour., 7 : 89.

KÜMMELL (C. H.) Can the parallax of the fixed stars be made perceptible? Astron. Nachr., 117 : 247.

LAGRANGE (C.) Méthode pour la détermination des parallaxes par des observations continues.

Rev.: Ciel et terre, 7 : 507.

LAMP (E.) Parallax von Σ 2398 (P. M. 2164). Astron. Nachr., 117 : 361–380.

PRITCHARD (C.) Application of photography to the determination of stellar parallax [of 61 Cygni]. Month. not., 47 : 87–89.

——— Parallax of 61^1 and 61^2 Cygni as obtained by the aid of photography. *Ibid.*, 444.

Parallax (Stellar)—*Continued.*

PRITCHARD (C.) Further researches on stellar parallax by the photographic method. *Ibid.*, 48: 27.

——— Nature of the photographic star-disks, and the removal of a difficulty in measurements for parallax. *Abstr.:* Nature, 36: 523.

RANYARD (A. C.) Photography and the determination of stellar parallax. Obsry., 10: 167.

Paris—École militaire.

BIGOURDAN (G.) Histoire des observatoires de l'école militaire. Bull. astron., 4: 497.

Paris—Société astronomique de France. *See* Société.

Paris observatory. *See, also,* Photographic congress.

Annales de l'observatoire de Paris publiées sous la direction de [E. A. B.] Mouchez. Observations 1882. 1032 p. 4to. Paris, 1887.

Catalogue de l'observatoire de Paris. Étoiles observées aux instruments méridiens de 1837 à 1881. Tome 1. 0^h à 6^h. 7 + 112 + 295 p. 4to. Paris, 1887.

——— Same. Positions observées des étoiles. 1837-1881. Tome 1. 0^h à 6^h. 22 + 336 p. 4to. Paris, 1887.

LOEWY (M.) & *others.* Étude de la flexion horizontale de la lunette du cercle méridien Bischoffsheim de l'observatoire de Paris. Compt. Rend., 104: 154-160.

Pearson (*Rev.* James) [1826-1886].

For Biography, *see* J. Liverp. astron. soc., 5: 26. *Also:* Month. not., 47: 139.

Pendulum.

VON REBEUR-PASCHWITZ (E.) Über das Zollner'sche Horizontalpendel und neue Versuche mit demselben. 25 p. 8vo. [n. p., n. d.]

——— Versuch die Veränderungen der Horizontalebene mit Hülfe eines Zöllner'schen Horizontalpendels photographisch zu registriren. Astron. Nachr., 118: 10-16.

VOGEL (H. C.) Isolirende Wirkung verschiedener Substanzen gegen strahlende Wärme. *Ibid.*, 98-104.

Personal equation.

CHRISTIE (W. H. M.) Description of the personal equation machine of the royal observatory, Greenwich. il. Month. not., 48: 1-4.

HILFIKER (J.) Über eine persönliche Gleichung bei Durchgangsbeobachtungen. Astron. Nachr., 118: 99-104.

SEELIGER (H.) Über den Einfluss dioptrischer Fehler des Auges auf das Resultat astronomischer Messungen. Abhandl. d. math.-phys. Cl. d. k. bayer. Akad. d. Wissensch. München, 15: 665-704, 1886.

TURNER (H. H.) Results obtained with the personal equation machine at the royal observatory, Greenwich. Month. not., 48: 4-18.

Discussed: Obsry., 10: 408.

Perturbations. *See, also,* Mechanics (Celestial).

BAILLAUD (B.) Sur le calcul des fonctions $R_{i,j}^{n}$ de M. Tisserand. Bull. astron., 4: 98.

GERTZ (J.) Allgemeine Methode zur Berechnung der speciellen Elementenstörungen in Bahnen von beliebiger Excentricität.

Anzeiger der Wiener Akademie 1887, Nr. 19. *Also, abstr.:* Astron. Nachr., 117: 327.

HERZ (N.) Notiz zur Störungsrechung. Astron. Nachr., 118: 118.

Photographic congress, Paris, 1887.

Congrés astrophotographique international tenu à l'observatoire de Paris pour le levé de la carte du ciel, avril, 1887. 8 + 106 p. 4to. Paris, 1887.

FLAMMARION (C.) Le congrés astronomique pour la photographie du ciel. L'Astron., 6: 161–169.

KNOBEL (E. B.) & *others.* [Report to Royal astronomical society on the Paris congress.] Obsry., 10: 210–218.

MOUCHEZ (E.) La photographie astronomique à l'observatoire de Paris et la carte du ciel. il. Ann. de bur. d. long., 1887: 755–842.

[Report of the proceedings of the Paris congress.] Bull. astron., 4: 129–134. *Also:* Nature, 35: 584; 36: 7, 54.

[Resolutions adopted.] Astron. Nachr., 116: 383. *Also:* Obsry., 10: 190.

[Summary of resolutions and photograph of members of the congress.] Sc. Am. sup. 9621.

Z. (K.) Beschlüsse der astronomisch-photographischen Versammlung in Paris und deren Folgen. Sirius, 20: 231–235.

Photography (Astronomical). *See, also,* Aberration (Constant of); Nebulæ; Objectives; Photographic congress; Photography (Stellar); Spectra (Stellar); Spectroscope.

ABNEY (W. de W.) Atmospheric transmission of visual and photographically active light. Month. not., 47: 260–265.

GILL (D.) The applications of photography in astronomy. Obsry., 10: 267, 283. *Also, trans.:* Bull. astron., 4: 361–380.

Lecture before Royal institute, 1887, June 3.

VON GOTHARD (E.) Über Himmels-und Spectral-Photographie. Vrtljschr. d. astron. Gesellsch., 22: 336–341.

VON KONKOLY (E.) Praktische Anleitung zur Himmelsphotographie nebst einer Anleitung zur Spectralphotographie. 8vo. Halle, 1887. (M. 12.)

M. (L.) Ligeiro historico da photographia celeste. Rev. d. obsrio., 2: 87–92.

MOUCHEZ (E.) La photographie astronomique à l'observatoire de Paris et la carte du ciel. il. Ann. de bur. d. long. 1887: 755–842.

PRINZ (W.) La photographie astronomique par les petits appareils. il. Ciel et terre, 8: 201–208.

PRITCHARD (C.) Remarks on some of the present aspects of celestial photography. Month. not., 47: 322–324.

RAYET (G.) Notes sur l'histoire de la photographie astronomique. Bull. astron., 4: 165, 262, 307, 344, 449. *Also,* Reprint. (2 fr.)

Photography (Astronomical)—*Continued.*

Roberts (I.) Photographic search for the minor planet Sappho. Month. not., 47: 265.

Spitaler (R.) Mondphotographie. Sirius, 20: 75, 101.

Taylor (J. T.) Photographic lenses. Eng. mec., 44: 495, 517.

Valentiner (W.) Entwicklung der Photographie in ihrer Anwendung auf die Astronomie. 16 p. 8vo. [n. p., 1887.]

Young (C. A.) Astronomical photography. New Princeton rev., 3: 354–369. *Also, abstr.:* Obsry., 10: 239. *Also, abstr.:* Nature, 36: 113.

Photography (Stellar). *See, also,* Parallax (Stellar); Spectra (Stellar).

Backhouse (T. W.) Examination of stellar photographs [with a stereoscope]. Obsry., 10: 196.

Barnard (E. E.) Recent stellar photography. Sid. mess., 6: 59–65.

Criswick (G. S.) [Photographs of star groups taken at Greenwich for determining distortion of the plate.] *Abstr.:* Obsry., 10: 407.

Dreyer (J. L. E.) Effect of refraction in stellar photography. Month. not., 47: 421.

Espin (T. E.) Stellar photography: the Liverpool astronomical society's research . . . Eng. mec., 44: 475.

Grubb (H.) Choice of instruments for stellar photography. Month. not., 47: 309–322. *Also, abstr.:* Nature, 36: 523.

Knobel (E. B.) Examination of stellar photographs [with a stereoscope]. Obsry., 10: 231.

Mouchez (E.) Préparatifs d'execution de la carte du ciel. Compt. Rend., 105: 631.

Roberts (I.) Measurement of celestial photographs. Month. not., 48: 31.

Rogers (W. A.) Determination of the coefficients of expansion of the glass plates used for stellar photography at Cordoba in the years 1872 to 1876, and 1880 to 1883. Astron. jour., 7: 123.

Scheiner (J.) Einfluss verschiedener Expositionszeiten auf die Exaktheit photographischer Sternaufnahmen. Astron. Nachr., 118: 153–156.

Wolf (M.) Astrophotographisches Okular. il. Astron. Nachr., 118: 79.

Photometers.

Cornu (A.) Sur quelques dispositifs permettant de réaliser sans polariser la lumière des photomètres biréfringents. Bull. astron., 4: 89–94.

von Gothard (E.) Keilphotometer mit Typendruck-Apparat. il. Ztschr. f. Instrmknd., 7: 347–349.

Langley (S. P.), Young (C. A.) & Pickering (E. C.) Pritchard's wedge-photometer. Mem. Am. acad. arts & sc., 11: 301–324 (v. 11, pt. 5, no. 6). *Also,* Reprint.

Spitta (E. J.) Pritchard's photometer. Obsry., 10: 389.

Photometry.

Ceraski (W.) Photometrische Helligkeiten von 58 Sternen. Astron. Nachr., 116: 363.

Photometry—*Continued.*

LINDEMANN (E.) Grossenclassen der Bonner Durchmusterung. Astron. Nachr., 118: 126.

MACHE (J.) Abhängigkeit der Helligkeit der Sterne von der Pupillenöffnung. 10 p. 8vo. Halle, 1887. (M. 0.40.)

PICKERING (E. C.) Magnitudes of stars employed in various nautical almanacs. Ann. Harv. coll. obsry., 18: 1–18 (v. 18, no. 1). *Also*, Reprint.

——— Discussion of the Uranometria Oxoniensis. Ann. Harv. coll. obsry., 18: 15–27 (v. 18, no. 2). *Also*, Reprint.

——— Magnitudes of circumpolar stars determined at the observatories of Moscow and of Harvard college. Astron. Nachr., 117: 139.

SAFARIK (A.) Lichtwechsel einer Anzahl von Sternen aus der Bonner Durchmusterung und aus den Katalogen rother Sterne von Schjellerup und Birmingham. 16 p. 8vo. Prag, 1887. (M. 1.20.)

SCHEINER (J.) Vergleichung der Grossenangaben der südlichen Durchmusterung mit denen anderer Cataloge. Astron. Nachr., 116: 81–94.

WOLFF (T.) Photometrische Arbeiten über die Sterne der Bonner Durchmusterung. Vrtljschr. d. astron. Gesellsch., 22: 366–386.

Plana (Giovanni) [1781–1864].

REALIS (S.) Giovanni Plana, né à Voghera le 8 novembre, 1781, mort à Turin le 20 janvier, 1864. 10 p. 4to. Roma, 1887.

Planets. *See, also*, Gravitation; Solar system.

BERBERICH (A.) Sternbedeckungen durch Planeten im Jahre 1888. Astron. Nachr., 118: 81–90.

CALLANDREAU (O.) Sur la théorie de la figure des planètes. 84 p. 4to. [Paris, 1887?]

Ann. d. l'obs. d. Paris. Mém. 19, E. *Also, abstr.:* Compt. Rend., 104: 1600.

——— Recherches sur la théorie de la figure des planètes; étude spéciale des grosses planètes. *Abstr.:* Compt. Rend., 105: 1171–1173.

DARWIN (G. H.) Figures of equilibrium of rotating masses of fluid. Proc. roy. soc., 42: 359. *Also, abstr.:* Bull. astron., 4: 524–526.

GÉRIGNY (P.) Comment on pèse les mondes. il. L'Astron., 6: 81–92, 366–378.

HAMY (M.) Étude sur la figure des corps célestes. Paris, 1887.

MONCK (W. H. S.) Periods of the planets and satellites. Obsry., 10: 322, 425.

SEELIGER (H.) Zur theorie der Beleuchtung der grossen Planeten insbesondere des Saturn. Abhandl. d. math.-phys. Cl. d. k. bayer. Akad. d. Wissensch. München, 16: 405–516.

ZENGER (C. V.) Periods of the planets. Obsry., 10: 391–395.

Planets (Intra-Mercurial).

BACKHOUSE (T. W.) Search for Vulcan. J. Liverp. astron. soc., 5: 8.

BROWN (E.) Search for Vulcan. *Ibid.*, 146, 197.

COLBERT (E.) The Swift-Watson intra-Mercurial observations. Sid. mess., 6: 84.

Planets (Intra-Mercurial)—*Continued.*

[Review of original observations of Swift and Watson.] il. *Ibid.*, 196.

YOUNG (C. A.) The Swift-Watson intra-Mercurial observations. *Ibid.*, 617.

Planets (Minor). *See* Asteroids.

Planets (Ultra-Neptunian).

LYNN (W. T.) Suggested mean distances of ultra-Neptunian planets. Obsry., 10: 319.

Planisphere.

FENET (L.) Planisphère céleste mobile donnant les étoiles visibles à toute heure audessus de nos têtes, dressé sous la direction de C. Flammarion. Paris, 1887. (8 fr.)

Pleiades.

DORST (—) Bestimmung der Helligkeit der Plejaden nach den photographischen Aufnahmen der Gebrüder Henri in Paris. Sirius, 20: 83.

ELKIN (W. L.) Determination of the relative positions of the principal stars in the group of the Pleiades. 105 p. 4to. New Haven, 1887.

Trans. astron. obsry. Yale univ. v. 1 pt. 1.

——— [Remarks on his observations of the Pleiades.] Obsry., 10: 152.

HALL (A.) Relative positions of 68 small stars in the Pleiades. Astron. jour., 7: 73–78.

WESLEY (W. H.) The nebulæ in the Pleiades. il. J. Liverp. astron. soc., 5: 148–150.

Pothenot's problem.

OUDEMANS (J. A. C.) Losung des sog. Pothenot'schen, besser Snellius'schen Problems, von Ptolemæus. Vrtljschr. d. astron. Gesellsch., 22: 345–349.

Potsdam observatory.

Publicationen der astrophysikalischen Observatoriums zu Potsdam No. 17 (Bd. 4. Stück 4.) Beobachtungen von Sonnenflecken in den Jahren 1880–84 von G. Spörer. 4to. Leipzig, 1887. (M. 10.)

——— Same. Nr. 21. (Bd. 6. Stück 1). Bestimmung der Polhöhe des astrophysikalischen Observatoriums zu Potsdam von P. Kempf. 4to. Leipzig, 1887. (M. 2.)

——— Same. Nr. 22 (Bd. 6. Stück 2). Bestimmung des mittleren Dichtigkeit der Erde mit Hülfe eines Pendelapparates von J. Wilsing. 4to. Leipzig, 1887. (M. 5.)

VOGEL (H. C.) [Report for 1886.] Vrtljschr. d. astron. Gesellsch., 22: 140–151.

Prague observatory.

SAFARIK (A.) [Report for 1886.] *Ibid.*, 151.

Precession. *See, also,* Star-places.

FLAMMARION (C.) Movimento secular do polo e a transloção do systema solar. il. Rev. d. obsrio., 2: 6–10.

KREUTZ (H.) Hülfsgrössen zur Berechnung der Präcession nach Struve fur mehrere öfters vorkommende Epochen. Astron. Nachr., 118: 91. *Also,* Reprint.

Precession—*Continued.*

SAFFORD (T. H.) Reduction of star-places by Bohnenberger's method. Month. not., 48: 20-26.

STRUVE (L.) Bestimmung der Constante der Praecession, und der eigenen Bewegung des Sonnensystems. 34 p. 4to. Leipzig, 1887. (M. 1.)

Mem. acad. imp. d. sc. de St. Petersb. 7. s. 35, no. 3.

Prizes (Astronomical).

Danish academy. Prix de l'académie royale Danoise des sciences et des lettres. Astron. Nachr., 117: 63. *Also:* Bull. astron., 4: 163.

Paris academy. Tableau des prix décernées. Année 1887. Compt. Rend., 105: 1413.

Royal astronomical society. Address by the president . . . on presenting the gold medal to G. W. Hill. Month. not., 47: 203-220.

[Schubert'schen Preis der Akademie in St. Pétersburg.] Astron. Nachr., 118: 30.

WARNER (H. H.) Conditions of awarding the Warner comet prizes from Apr. 1, 1887, to Apr. 1, 1888. Sid. mess., 6: 225.

Projections.

RADAU (R.) Sur une application de la projection stéréographique [de la sphère]. Bull. astron., 4: 49.

Prominences (Solar). *See, also,* Chromosphere; Sun (Statistics of faculæ, prominences, spots, etc., for 1886).

FENYI (J.) Grande éruption solaire du 1er juillet 1887, observée á l'observatoire Haynald à Kalocsa. 1 pl. Mem. soc. spettrscp. ital., 16: 102-105. *Also:* L'Astron., 6: 416-419.

RICCÒ (A.) Protuberanze solari osservate nel regio osservatorio di Palermo nell' anno 1886. Mem. soc. spettrscp. ital., 16: 65-79.

TACCHINI (P.) Sulle eruzioni metalliche solari osservate al regio osservatorio del collegio Romano nel 1886. *Ibid.*, 8-10.

——— Sui fenomeni della cromosfera solare osservati al r. osserv. del collegio Romano nel 4° trimestre, 1886. [Protuberanze.] Atti d. r. accad. d. Lincei, s. 4. Rendic., 3: 13.

——— Same. 1° trimestre, 1887. *Ibid.*, 265.

——— Osservazioni spettroscopiche solari fatte nel regio osservatorio del collegio Romano nel 1° trimestre del 1887. Protuberanze. Mem. soc. spettrscp. ital., 16: 37, 51.

——— Same. 2° trimestre, 1887. *Ibid.*, 91, 111.

——— Same. 3° trimestre, 1887. *Ibid.*, 123.

——— Observations solaires du deuxième semestre, 1886. Compt. Rend., 104: 216.

——— Same. 1er trimestre, 1887. *Ibid.*, 104: 1082; 105: 210.

——— Same. 2e trimestre, 1887. *Ibid.*, 105: 211.

——— Same. 3e trimestre, 1887. *Ibid.*, 105: 1002.

TROUVELOT (E. L.) Nouvelle éruption solaire [1887, June 24]. 3 p. 4to. [Paris, 1887.]

Repr. from: Compt. Rend., 105: 610.

Proper motion. *See, also,* Nebulæ.

Boss (L.) [Proper motion of Lal. 28551.] Astron. jour., 7: 103.

Bossert (J.) Détermination des mouvements propres des étoiles. [Explication des discordances trouvées dans la comparaison] du catalogue de Paris [avec celui de Lalande.] Bull. astron., 4: 509–515.

Flammarion (C.) Mouvement propre d'une étoile observée à l'œil nu. [61 Virginis.] il. L'Astron., 6: 441–448.

Frisby (E.) [Approximate proper motion of Groombridge 3215.] Astron. jour., 7: 78.

Gore (J. E.) Proper motion of 40 (o^2) Eridani. J. Liverp. astron. soc., 5: 140.

von Gothard (E.) & Vogel (H. C.) Muthmassliche starke Eigenbewegung eines Sterns im Sternhaufen G. C. 4440. Astron. Nachr., 116: 258.

Kam (N. M.) Eigenbewegung einiger Sterne aus den Helsingforser Zonen-Beobachtungen der A. G., zwischen 55° und 65° nördlicher Declination. *Ibid.*, 117: 349–356.

Leavenworth (F. P.) [Proper motion of Lal. 4219.] Sid. mess., 6: 80.

Lynn (W. T.) [Erroneous proper motion of θ^2 Tauri.] Obsry., 10: 367.

Pomerantzeff (H.) [Proper motion of Lal. 30479.] Astron. Nachr., 116: 359.

——— [Proper motion of Lal. 30474.] *Ibid.*, 359.

von Rebeur-Paschwitz (E.) Verzeichniss einiger Sterne mit merklicher Eigenbewegung. *Ibid.*, 117: 291.

Sadler (H.) Proper motion of the "Sidus Ludovicianum." J. Liverp. astron. soc., 198–200.

——— Proper motion of Lal. 14551, U Puppis. *Ibid.*, 142.

——— Proper motions of β, γ, δ, ε, ζ, Ursæ Majoris, and Alcor. Eng. mec., 45: 124.

Svedstrup (A.) [Proper motion of stars used in determining the orbit of Comet 1863 IV.] Astron. Nachr., 117: 232.

Weiss (E.) [Proper motion of SD.—3°, 5577.] Astron. Nachr., 116: 354.

——— Eigenbewegung von Lal. 18069. *Ibid.*, 259.

Pulkowa observatory.

Nyrén (M.) Polhöhenbestimmungen mit dem Ertel-Repsold'schen Verticalkreise. Mél. math. astron., 6: 449–462.

Punta Arenas.

Cruls (L.) Longitude de Punta Arenas. Rev. d. obsrio., 2: 18–20. *Also:* Compt. Rend., 104: 346.

Radcliffe observatory.

[Report for 1886.] Month. not., 47: 155.

Results of astronomical and meteorological observations made at the Radcliffe observatory, Oxford, in . . . 1884, under the superintendence of E. J. Stone. Vol. 42. 290 p. 8vo. Oxford, 1887.

Red stars.

Chambers (G. F.) A working catalogue of red stars. Month. not., 47: 348–387.

Red stars—*Continued.*

Espin (T. E.) New red star near 26 Cygni. Astron. Nachr., 116: 319. *Also:* Obsry., 10: 175.

——— Unpublished red stars detected by Rev. T. W. Webb. J. Liverp. astron. soc., 5: 105.

——— Sweeping for red stars and stars with remarkable spectra. Obsry., 10: 258-260.

Millosevich (E.) Sulla nuova stella rossa presso 26 Cygni. Astron. Nachr., 116: 365; 117: 61.

Schröder (H. C.) Chambers' neues Verzeichniss von roten Sternen. Sirius, 20: 223, 256, 279.

Refraction.

Chandler (S. C.) jr. Note on an inaccuracy in the development of a differential refraction formula. [In Brünnow's astronomy.] Astron. jour., 7: 53.

Comstock (G. C.) New mode of determining the constants of refraction and aberration. Sid. mess., 6: 310-317.

[Eastman (J. R.)] Refraction tables, U. S. naval observatory, 1887. 37 p. 4to. Washington, 1887.

Schaeberle (J. M.) Short method for computing astronomical refractions between 0° and 45° zenith distance. Astron. Nachr., 116: 115.

——— Short method of computing with Bessel's constants the true refractions for all zenith distances. *Ibid.*, 117: 53.

Trépied (C.) Sur l'application de la photographie aux nouvelles méthodes de M. Loewy pour la détermination des éléments de la réfraction et l'aberration. Compt. Rend., 104: 414-417.

Rigaud [1774-1839].

Lynn (W. T.) [Biographical note.] Obsry., 10: 69.

Rio Janeiro observatory.

Annales de l'observatoire de Rio Janeiro . . . par L. Cruls. Tome 3. Observation du passage de Vénus en 1882. il. 708 p. 4to. Rio de Janeiro, 1887.

Cruls (L.) Transferencia do observatorio. Rev. d. obsrio., 2: 1.

See, also, Nature, 35: 593.

Revista do observatorio. Publicaçao mensal do imperial observatorio do Rio de Janeiro. Anno 2, 1887. Red. L. Cruls [& *others*]. 8 + 198 p. 4to. Rio de Janeiro, 1887.

Royal astronomical society.

Monthly notices . . . Nov., 1886, to Nov., 1887. Vol. 47. 8vo. London, 1887.

Report of the council to the 67th annual general meeting. Month. not., 47: 121-132.

Saros.

Noble (W.) Length of the Saros. Obsry., 10: 423.

Satellites (Formation of). *See* Planets.

Satellites (Orbits of).

MARTH (A.) Formulæ for computing the apparent positions of a satellite, and for correcting the assumed elements of its orbit. Month. not., 47: 333–346. *Also*, Reprint.

Saturn.

ELGER (T. G.) Physical observations of Saturn in 1887. il. Month. not., 47: 511–515.

—— [Observations of] the dark ring of Saturn, [1887, Feb.] Obsry., 10: 161.

—— [Physical appearance, 1887, Feb. and Mar.] il. J. Liverp. astron. soc., 5: 196.

GREEN (N. E.) [Observations of] the outer ring of Saturn: Encke's division. Obsry., 10: 139.

LOHSE (J. G.) [Observations 1885, Nov. 17—1886, Mar. 25.] Month. not., 47: 496.

VON SPIESSEN (—) Encke'sche Theilung des Saturnringes. Astron. Nachr., 116: 245.

STUYVAERT (E.) Division de Struve dans l'anneau de Saturne. il. L'Astron., 6: 207.

TEBBUTT (J.) Observations of Saturn and δ Geminorum. [1887, Jan. 30—Feb. 14.] Month. not., 47: 431.

TERBY (F.) Nouvelles observations sur Saturne. il. L'Astron., 6: 203–209.

—— Observation de Saturne faite a Louvain [1886, Dec. 25.] 4 p. 8vo. [Bruxelles, 1887.]

Bull. d. l'acad. roy. d. Belg., 3. s. 13. no. 2.

—— Phénomènes observées sur Saturne [1887, Jan., Feb.] 8 p., 1 pl. 8vo. [Bruxelles, 1887.]

Bull. d. l'acad. roy. d. Belg., 3. s. 13. no. 3.

—— [Observation of Encke's division.] Obsry., 10: 107.

—— [Observations of physical appearance 1886–87.] *Ibid.*, 137.

—— [Sketch 1887, Feb.] il. Astron. Nachr., 116: 327. *Also:* Obsry., 10: 163.

—— [Change in the ring.] Obsry., 10: 231.

WILLIAMS (A. S.) Present aspect of the rings of Saturn. *Ibid.*, 105.

Saturn (Satellites of).

VON ENGELHARDT (B.) Mikrometrische Beobachtungen der Saturnsatelliten. Astron. Nachr., 117: 137.

PERROTIN (J.) Observations des satellites Hypérion, Ariel, Umbriel. Bull. astron., 4: 339.

Sayre observatory.

DOOLITTLE (C. L.) Latitude of the Sayre observatory. Astron. jour., 7: 14.

Scarborough observatory (Wigglesworth's).

[Report for 1886.] Month. not., 47: 162.

Schjellerup (H. C. F. C.) [1827–1887].

DREYER (J. L. E.) [Obituary notice.] Nature, 37: 154.

THIELE (T. N.) Todes-Anzeige. Astron. Nachr., 118: 95.

Scholl observatory.

Kershner (J. E.) [Equipment of the Daniel Scholl observatory, Lancaster City, Penn.] Science, 9: 462.

Scintillation.

Exner (K.) Über die Scintillation. Repert. d. Phys., 23: 371, 426. *Also*, Reprint.

——— Über die Aufstellung grosser Instrumente. Astron. Nachr., 117: 105.

Sextant.

Corrigan (S. J.) Method of deriving the right ascension and declination of a heavenly body from sextant observations, and its application to the determination of terrestrial longitude. Sid. mess., 6: 175–188. *Also, transl.:* Rev. d. obsrio., 2: 122, 135.

Fleuriais (G.) Gyroscope-collimateur: substitution d'un repère artificiel à l'horizon de la mer. il. 61 p. 8vo. Paris, 1887.
Repr. from: Rev. marit. et colon., Dec., 1886.

Thompson (C. W.) Manual of the sextant: containing instruction for its use in determining time, latitude, and longitude, and the variation of the compass. 106 p. 8vo. London, 1887. (M. 6.30.)

Sirius.

Lynn (W. T.) The alleged change in the color of Sirius. Obsry., 10: 104, 194.

Sirius (Companion of).

Hall (A.) Observations of the companion of Sirius, 1887. Astron. jour., 7: 99.

Hough (G. W.) Observations . . . [1887]. Month. not., 47: 478.

Young (C. A.) [Observations 1887, Jan. 27—Apr. 7.] Obsry., 10: 263.

Sky-glows.

Abercromby (R.) Upper wind currents near the equator, and the diffusion of Krakatâo dust. il. Nature, 36: 85.

Busch (F.) Über die Dämmerung, insbesondere über die glänzenden Erscheinungen des Winters 1883–84. 33 p. 4to. Arnsberg, 1887. (M. 1.50.)

Fenomeni crepuscolari nel 1883 e 1884. Mem. soc. spettrscp. ital., 16: 58–64.

Riccò (A.) Sopra i fenomeni crepuscolari del 1883 e del 1884. *Ibid.*, 106–109.

Societé astronomique de France.

[Constitution, by-laws, officers, etc.] L'Astron., 6: 406–413, 462–468. *Also:* Nature, 37: 66.

Solar system. *See, also*, Planets.

Delauney (J.) Sur les distances des planètes au soleil, et sur les distances des comètes périodiques. *Abstr.:* Compt. Rend., 105: 515

Ritter (A.) Untersuchungen über die Constitution gasförmiger Weltkörper. Repert. d. Phys., 20: 379–412. 1884.
Rev. by R. (R.) Bull. astron., 4: 190–206.

Struve (L.) Bestimmung der Constante der Praecession und der eigenen Bewegung des Sonnensystems. 34 p. 4to. Leipzig, [?] 1887. (M. 1.)
Mem. acad. imp. d. sc. de St. Petersb. 7. s. 35, no. 3.

Tisserand (F.) Commensurabilité des moyens movements dans le système solaire. Bull. astron., 4: 183–192. *Also:* Compt. Rend., 104: 259–265.

Spectra (Stellar).

COPELAND (R.) Variability of the spectrum of γ Cassiopeiæ. Month. not., 47: 92.

ESPIN (T. E.) Sweeping for red stars and stars with remarkable spectra. Obsry., 10: 258.

—— Stars with remarkable spectra. Astron. Nachr., 117: 49.

MAUNDER (E. W.) & *others*. [Remarks on Sherman's observations of bright lines in stellar spectra.] Obsry., 10: 51.

PICKERING (E. C.) Henry Draper memorial. First annual report of the photographic study of stellar spectra conducted at the Harvard college observatory. 10 p., 1 pl. 4to. Cambridge, 1887. (M. 3)

SHERMAN (O. T.) Stellar spectra of classes I *c* and II *b*. Astron. jour., 7: 33.

—— Spectra of the new variable in Orion, of certain temporary stars, and of the nebulas. *Ibid.*, 65–71.

—— Short study upon the atmosphere of β Lyræ. Am. j. sc., 133: 126–129.

Spektroskopische Beobachtung der Sterne bis zur 7.5 Gr. zwischen 0° und —15° Deklination auf der Sternwarte zu O'Gyalla. Sirius, 20: 252–255.

Stars with remarkable spectra. il. Nature, 36: 461.

Spectroscope.

HUTCHINS (C. C.) A new photographic spectroscope. Am. j. sc., 134: 58.

Spectrum analysis. *See, also,* Light.

GRÜNWALD (A.) Über die merkwürdigen Beziehungen zwischen dem Spektrum des Wasserdampfes und den Linienspectren des Wasserstoffs und Sauerstoffs, sowie über die chemische Struktur der beiden letztern und ihre Dissociation in der Sonnenatmosphäre. Astron. Nachr., 117: 201–214. *Also, transl.:* Phil. mag., 5. s. 24: 354–367.

VON KÖVESLIGETHY (R.) Mathematische Spektralanalyse. *Abstr.:* Astron. Nachr., 117: 329–338.

SHERMAN (O. T.) A continuous spectrum from hydrogen. Astron. jour., 7: 95.

Spectrum (Solar). *See, also,* Spectrum analysis.

ABNEY (W. de W.) Solar spectrum from λ 7150 to λ 10000. Phil. trans. roy. soc., 177: 457–469. *Also*, Reprint. (M. 3.30.)

HUTCHINS (C. C.) & HOLDEN (E. L.) Existence of certain elements, together with the discovery of platinum in the sun. Am. j. sc., 134: 451–456.

MENGARINI (G.) Il massimo d'intensita luminosa dello spettro solare. Atti d. r. accad. d. Lincei, s. 4. Rendic., 3: 482–489.

PICKERING (E. C.) [Device for detecting atmospheric lines in the solar spectrum.] Science, 9: 13.

ROWLAND (H. A.) Relative wave-length of the lines of the solar spectrum. Am. j. sc., 133: 182–190.

TROWBRIDGE (J.) & HUTCHINS (C. C.) Existence of carbon in the sun. Am. j. sc., 134: 345–348. *Also:* Phil. mag., 5. s. 24: 310–313.

—— Oxygen in the sun. Am. j. sc., 134: 263–270. *Also:* Phil. mag., 5. s. 24: 302–310.

Spherometer.

Czapski (S.) Neuere Sphärometer zur Messung der Krummung von Linsenflächen. il. Ztschr. f. Instrmknd., 7: 297–301.

Star-catalogues. *See, also*, Star-places.

Auwers (A.) A catalogue of 480 stars to be used as fundamental stars for observations of zones between 20° and 80° south declination. Month. not., 47: 455–473.

Backlund (O.) Studien über den Sterncatalog: positions moyennes de 3542 étoiles déterminées à l'aide du cercle méridien de Poulkova . . . 1840–1869. Mél. math. astron., 6: — [avril et sept. 1887.]

——— Pulkowaer Declinationsbestimmungen. Astron. Nachr., 118: 155–158.

Bryant (R.) [Errata in Glasgow and Romberg's catalogues.] *Ibid.*, 111.

[Cape catalogue, 1880—errata.] *Ibid.*, 117: 47.

Catalogue de l'observatoire de Paris. Positions observées des étoiles. 1837–1881. Tome 1. 0^h to 6^h. 22 + 336 p. 4to. Paris, 1887.

Chandler (S. C.) jr. Notes on some places of Auwers's fundamantal catalogue. Astron. jour., 7: 81.

Downing (A. M. W.) Comparison of the star-places of the Argentine general catalogue for 1875 with those of the Cape catalogue for 1880 and with those of other southern catalogues. Month. not., 47: 446–454. *Also:* Reprint.

——— Probable errors of the star-places of the Argentine general catalogue for 1875 and the Cape catalogue for 1880. Month. not., 48: 19.

Gould (B. A.) Corrections to the Uranometria argentina and the Cordoba catalogues. Astron. Nachr., 116: 379.

Lamb (A. M.) Index to certain classes of stars contained in the Greenwich catalogues, reduced to 1875.0. Pub. Washb. obsry., 5: 116–230.

Loewy (M.) Détermination des ascensions droites de 521 étoiles de culmination lunaire ou de longitude et d'un certain nombre de circumpolaires boréales basées sur 58860 observations effectuées entre les années 1868 et 1881. 117 p. 4to. Paris, 1887.

Mouchez (E.) [Notice of the Paris catalogue.] 4 p. 4to. Paris, 1887.

Repr. from: Compt. Rend., 105: 629–631.

Peters (C. H. F.) Flamsteed's stars "observed but not existing." Mem. nat. acad. sc., 8: 69–83. *Also*, Reprint.

——— Corrigenda in various star catalogues. Mem. nat. acad. sc., 8: 87–97. *Also*, Reprint.

O. Arg. S., Bonn VI, W_1, W_2, Rümker, Schj., Baily's Lal. zones, Yarnall, Glasgow, Santiago, Geneva.

——— [Progress of work upon a catalogue of 30,000 stars.] Sid. mess., 6: 352.

Porter (J. G.) Zone catalogue of 4,050 stars for the epoch 1885, observed with the 3-inch transit of the Cincinnati observatory. 104 p. 8vo. Cincinnati, 1887.

Seyboth (J.) Vergleichung des Pulkowaer Catalogs von 3542 Sternen für 1855 mti dem Cap-Catalog für 1880. Astron. Nachr., 118: 1–6.

Star charts.

KLEIN (H. J.) Stern-Atlas. Lfgn. 6, 7, 8. fol. Leipzig, 1887. (Jede Lfg. M. 1.20.)

SCHÖNFELD (E.) Bonner Sternkarten. Serie II. Atlas der Himmelszone zwischen 1° und 23° südlicher Declination. Lfg. 3. 5 maps. fol. Bonn, 1887. (M. 12.)

WEISS (E.) Bilderatlas der Sternenwelt. 54 p., 41 pl. 4to. Esslingen, 1887. (M. 12.)

Star-clusters.

GORE (J. E.) Absolute dimensions of a star-cluster. J. Liverp. astron. soc., 5: 169–171.

Star-places.

BIGOURDAN (G.) Réduction de la distance apparente de deux astres voisins à leur distance moyenne d'une époque donnée. Compt. Rend., 105: 606–608.

LEFAVOUR (H.) Right ascensions of certain stars within 10° of the pole. Reduced from observations by F. G. W. Struve. Month. not., 47: 423–426.

SAFFORD (T. H.) Observations of the mean right ascension of certain polar stars, made at the Field memorial observatory . . . and reduced to . . . 1884.0. Proc. Am. acad. arts & sc., 22: 1–18.

STONE (E. J.) Mean right ascensions of Polaris, 51 (H) Cephei, δ Urs. Min., and λ Urs. Min. for 1887, from the Radcliffe observations 1880–86. Month. not., 47: 85–87.

Stars. *See, also,* Colored stars; Double stars; Nova Andromedæ; Parallax (Stellar); Photometry; Proper motion; Red stars; Variable stars.

MAHLER (E.) Über den Stern mísri der Assyrer. 10 p. 8vo. Wien, 1887. (M. 0.20.)

MONCK (W. H. S.) Temperature of the stars. J. Liverp. astron. soc., 5: 172, 205.

Stars (Motion of) in the line of sight. *See, also,* Solar system.

SEABROKE (G. M.) Spectroscopic observations . . . made at the Temple observatory. Month. not., 47: 93–100.

Spectroscopic results . . . obtained at the Royal observatory, Greenwich, in 1886. *Ibid.*, 101–108.

Stockholm observatory.

GYLDÉN (H.) [Report for 1886.] Vrtljschr. d. astron. Gesellsch., 22: 153.

Stonyhurst college observatory.

[Report for 1886.] Month. not., 47: 157.

Results of meteorological and magnetical observations by S. J. Perry, 1886. 87 p. 12mo. Market Weighton, 1887.

Strassburg observatory.

KOBOLD (H.) [Report for 1886.] Vrtljschr. d. astron. Gesellsch., 22: 155–160.

SCHUR (W.) Geographische Lage der verschiedenen Beobachtungspunkte in Strassburg. Astron. Nachr., 116: 133.

Struve (O).

Adresse der k. preuss. Akad. d. Wissensch. an Hrn. Otto Struve zur Feier seines fünfzigjährigen Astronomenjubiläums und fünfundzwanzigjährigen Direktorjubiläums am 20. Februar, 1887. Sirius, 20: 97–101.

See, also, Nature, 35: 422.

Sun. *See, also*, Chromosphere; Corona; Eclipse; Faculæ; Prominences; Spectrum (Solar); Sun (Diameter of); Sun-spots; Sun (Statistics, etc.)

Abney (W. de W.) Sunlight colors. Nature, 35: 498–501.

Bigelow (F. H.) Phenomena of solar vortices. *Abstr.:* Proc. Am. ass. adv. sc., 36: 62. *Also*, Reprint.

[Braun (P.)] Sunto della teoria solare del P. Braun. Mem. soc. spettrscp. ital., 16: 43–50.

Brothers (A.) Comparison of drawings and photographs of sun-spots and the sun's surface. Proc. Manchester lit. & phil. soc., 26: 74–78.

Coakley (G. W.) Motion of the sun in reference to the centre of gravity of the solar system. Papers Am. astron. soc., 1: 33–44.

Crofton (W. J.) [Abstract of] Braun's theory of the sun. Obsry., 10: 295.

Filachou (J. E.) Principes de physique solaire. 106 p. 12mo. Montpellier. 1887.

Frölich (O.) Messungen der Sonnenwärme. 2. Abhandl. il. Ann. d. Phys. u. Chem., n. F. 30: 582–620.

Langley (S. P.) Sunlight colors. Nature, 36: 76.

Levison (W. G.) Note on periods of stationary temperature accordant with a steadily cooling sun. Papers Am. astron. soc., 1: 44–48.

Lockyer (J. N.) The chemistry of the sun. 19 + 457 p. 8vo. London, 1887. (M. 14.50.)

Schulz (J. F. H.) Zur Sonnenphysik. Astron. Nachr., 118: 129–146.

Stanoiéwitch (G. M.) Photographie directe de l'état barométrique de l'atmosphere solaire. Compt. Rend., 104: 1263–1265.

Thomson (W.) Probable origin, the total amount, and the possible duration of the sun's heat. Nature, 35: 297–300. *Also:* Pop. sc. month., 31: 19–29.

Zenger (K. W.) Die Meteorologie der Sonne und die Wetterprognose des Jahres 1886. 63 p. 8vo. Prag, 1887. (M. 8.)

Sun (Diameter of).

Auwers (A.) Neue Untersuchungen über den Durchmesser der Sonne, II. Sitzungsb. d. k. preuss. Akad. d. Wissensch. 1887: 449–486. *Also*, Reprint. (M. 1.80.)

di Legge (A.) Sul diametro solare. Atti d. r. accad. d. Lincei, 1884–85, s. 4. Mem. d. cl. d. sc. fisich., 1: 232-281.

Sunshine recorder.

Maurer (J.) Neue einfache Form des photographischen Sonnenscheinautographen. il. Ztschr. f. Instrmknd., 7: 238.

Sun-spots. *See, also*, Sun (Statistics of faculæ, prominences, spots, etc., for 1886).

Bigelow (F. H.) Sun-spots as vortex rings. Sid. mess., 6: 139–151.

Sun-spots—*Continued.*

Brothers (A.) Comparison of drawings and photographs of sun-spots and the sun's surface. Proc. Manchester lit. & phil. soc., 26: 74–78.

Brown (E.) Remarkable sun-spots [1886, May]. il. J. Liverp. astron. soc., 5: 50.

Jacquot (M.) & Bruguière (—). [Distinguished a group of 36 spots with the naked eye, 1887, Dec. 19.] L'Astron., 7: 33.

Landerer (J. J.) Grande tache solaire de Juin 1887. il. *Ibid.*, 6: 308.

Markwick (E. E.) Some typical sun-spots. il. J. Liverp. astron. soc., 5: 144–146.

Measures of positions and areas of spots and faculæ . . . on photographs taken . . . at Greenwich, in India, and in the Mauritius. Greenw. spectrosc. obsns. 1885: 34–104.

Spörer (G. F. W.) Periodicität der Sonnenflecken seit dem Jahre 1618, vornehmlich in Bezug auf die heliographische Breite derselben, und Hinweis auf eine erhebliche Störung dieser Periodicität während eines langen Zeitraumes. Vrtljschr. d. astron. Gesellsch., 22: 323–329.

——— Beobachtungen von Sonnenflecken in den Jahren 1880–84. Pub. d. astrophys. Obs. zu Potsdam, 4: 219–427 (Bd. 4, Stück 4). *Also:* Reprint. (M. 10.)

Tacchini (P.) Observations solaires du deuxième semestre, 1886. Compt. Rend., 104: 216.

——— Same. 1er trimestre, 1887. Compt. Rend., 104: 1082; 105: 210.

——— Same. 2e trimestre, 1887. *Ibid.*, 105: 211.

——— Same. 3e trimestre, 1887. *Ibid.*, 105: 1002.

——— Osservazioni di macchie e facole solari [4° trimestre, 1886]. Atti d. r. accad. d. Lincei, s. 4. Rendic., 3: 14.

——— Same. 1° trimestre, 1887. *Ibid.*, 265.

——— Macchie solari osservate a Roma nel 1886. Mem. soc. spettrscp. ital., 16: 1–3.

——— Macchie e facole solari osservate al regio osservatorio del collegio Romano nel 1° trimestre del 1887. *Ibid.*, 33–36, 54–57.

——— Same. 2° trimestre, 1887. *Ibid.*, 87–90.

——— Same. 3° trimestre, 1887. *Ibid.*, 118.

Taches solaires à colorations rouges. L'Astron., 6: 59–62.

Veeder (M. A.) [Spots visible 1886, Nov. and Dec.] Nature, 35: 584.

Wolf (R.) [Statistics for 1886.] Vrtljschr. d. astron. Gesellsch., 22: 164

Sun (Statistics of faculæ, prominences, spots, etc., for 1886).

Riccò (A.) Osservazioni astrofisiche solari eseguite nel regio osservatorio di Palermo: statistica delle macchie e delle facole nell' anno 1886. Mem. soc. spettrscp. ital., 16: 11–16.

Solar activity in 1886. Obsry., 10: 197–199.

Tacchini (P.) Distribuzione delle protuberanze idrogeniche alla superficie del sole durante l'anno 1886. Atti d. r. accad. d. Lincei, s. 4. Rendic., 3: 117.

Sun (Statistics of faculæ, prominences, spots, etc., for 1886)—*Continued.*

TACCHINI (P.) Distribuzione in latitudine delle facole, macchie ed eruzioni solari durante il 1886. Atti d. r. accad. d. Lincei, s. 4. Rendic., 3: 185.

——— Distribution en latitude des phénomènes solaires pendant l'année 1886. Compt. Rend., 104: 671.

——— Macchie solari osservate a Roma nel 1886. Mem. soc. spettrscp. ital. 16: 1–3.

WOLF (R.) Sonnen-statistik für 1886. Astron. Nachr., 116: 259. *See, also,* Vrtljschr. d. astron. Gesellsch., 22: 164.

——— Statistique solaire de l'année 1886. Compt. Rend., 104: 160.

Tables (Logarithmic).

AUGUST (E. F.) Vollständige logarithmische und trigonometrische Tafeln. 15. ed. 6 + 204 p. 8vo. Leipzig, 1887. (M. 1.60.)

BOURGET (J.) Tables de logarithmes à 5 décimales des nombres et des lignes trigonométrique. 287 p. 16mo. Paris, 1887.

BREMIKER (C.) Logarithmisch-trigonometrische Tafeln mit 5 Decimalstellen. 5. Aufl. von A. Kallius. 183 p. 8vo. Berlin, 1887. (M. 1.50.)

DUPUIS (J.) Tables des logarithmes à 5 décimales d'après J. de Lalande . . . 4 + 230 p. 16mo. Paris, 1887. (M. 2.)

GAUSS (F. G.) Fünfstellige vollständige logarithmische und trigonometrische Tafeln. 26. ed. 162 + 34 p. 8vo. Halle, 1887. (M. 2.)

GERNERTH (A.) Fünfstellige gemeine Logarithmen der Zahlen und Winkelfunctionen von 10 zu 10 Secunden nebst den Proportiontheile ihrer Differenzen. 2. ed. 8 + 133 p. 8vo. Wien, 1886. (M. 3.40.)

KÖHLER (H. G.) Logarithmisch-trigonometrisches Handbuch. 15. ed. 36 + 388 p. 8vo. Leipzig, 1887. (M. 3.)

REX (F. G.) Tables de logarithmes à cinq décimales. 17 + 174 + 8 p. 8vo. Stuttgart, 1887.

SCHRÖN (L.) Tables de logarithmes à 7 décimales . . . precédées d'une introduction par J. Hoüel. 2 v. 4to. Paris, 1887. (M. 9.)

WITTSTEIN (T.) Fünfstellige logarithmisch-trigonometrische Tafeln. 12. ed. 36 + 186 p. 8vo. Hannover, 1887.

WOODWARD (C. J.) A B C five figure logarithms. Differences on a new and simple plan. 58 p. 16mo. London, 1887. (M. 2.70.)

Tacubaya observatory.

PRITCHETT (H. S.) Exchange of longitude-signals between St. Louis and Mexico. Astron. jour., 7: 62.

Talmage (Charles George) [1840–1886].

For Biography, *see* Month. not., 47: 142. *Also,* Obsry., 9: 175

Taschkent observatory.

POMERANTZEFF (H.) [Report for 1886.] Vrtljschr. d. astron. Gesellsch., 22: 161–163.

Telescopes. *See, also,* Objectives.

Anleitung zur Herstellung von Fernrohren. Sirius, 20: 275–279.

Telescopes—*Continued.*

Astronomical telescopes at the Manchester exhibition. Engineering, 44: 630.

Denning (W. F.) Telescopes and telescopic work. J. Liverp. astron. soc., 5: 9, 57, 121, 153, 176, 211, 232.

Exner (K.) Aufstellung grosser Instrumente. Astron. Nachr., 117: 105.

Hiscox (G. D.) Limit of available power in great telescopes. Sc. Am., 56: 344. *Also:* Papers Am. astron. soc., 1: 41–43.

——— Astronomical telescopes: their object-glasses and reflectors. il. Sc. Am. sup. 9283, 9296, 9312.

Rozé (C.) Instruments à lunette fixe équivalents au cercle méridien ou à l'équatorial. Compt. Rend., 104: 1090.

——— Nouveaux moyens de repérer l'axe optique d'une lunette par rapport à la verticale. *Ibid.*, 1260–1263.

Young (C. A.) Great telescopes. Forum, 4: 78–86.

Telescopes (Reflecting).

Crossley (E.) Centering tube for reflecting telescopes. Month. not., 47: 274.

McLaren (—) Images formed by reflecting mirrors, and their aberration. il. Month. not., 47: 395–412.

Madsen (H. F.) Notes on the process of polishing and figuring 18-inch glass specula by hand, and experiments with flat surfaces. Eng. mec., 44: 515, 536.

Tennant (J. F.) Notes on reflecting telescopes. il. Month. not., 47: 244.

Temple observatory.

[Report for 1886.] Month. not., 47: 157.

[Report for 1887.] 3 p. 8vo. [n. p., n. d.]

Termoli.

Porro (F.) Determinazione della latitudine della stazione astronomica di Termoli . . . 23 p. 8vo. Torino, 1887.

Repr. from: Atti d. r. accad. d. sc. d. Torino, 22.

Thollon (L.) [–1887].

Janssen (J.) [Obituary notice.] Compt. Rend., 104: 1047. *See, also,* L'Astron., 6: 194.

Three bodies (Problem of). *See, also,* Mechanics (Celestial).

Brendel (M.) Über einige in neuerer Zeit angewandte Formen für die Differentialgleichungen im Probleme der drei Körper. Astron. Nachr., 116: 161–166.

Harzer (P.) Untersuchungen über einen speciellen Fall des Problems der drei Körper. 156 p., 1 pl. 4to. St. Petersburg, 1887. (M. 4.50.)

Tides.

Dufour (C.) Les courants de la mer et l'attraction de la lune. L'Astron., 6: 48.

Time (Determination of). *See, also,* Interpolation.

d'Abbadie (A.) Sur la manière la plus commode de trouver l'heure. Compt. Rend., 104: 1214.

Time-services. *See, also,* Clocks.

KEELER (J. E.) Time-service of the Lick observatory. 16 p. 8vo. [Northfield, 1887.]

Repr. from: Sid. mess., 6: 233-248.

Time (Standard).

[Adoption of even hours from Greenwich in America and Norway.] Ciel et terre, 8: 55.

[ALLEN (W. F.) & FLEMING (S.) Reports on introduction of standard time, etc.] Science, 9: 7.

FLEMING (S.) [Introduction of new system of time into Canada.] Obsry., 10: 221.

Transit observations.

FINLAY (W. H.) Probable errors of transit-observing. Month. not., 47: 427.

Tycho Brahe.

BURCKHARDT (F.) Aus Tycho Brahe's Briefwechsel. 28 p. 4to. Basel, 1887. (M. 1.60.)

Uccle observatory.

VINCENT (J.) Le nouvel observatoire d'Uccle, près Bruxelles. il. Ciel et terre, 8: 105-110.

United States naval observatory.

LAUSSEDAT (A.) Organisation des services astronomiques aux États-Unis. Compt. Rend., 105: 488-491.

Observations made during the year 1883 at the United States naval observatory, R. W. Shufeldt, superintendent. 483 p. 4to. Washington, 1887.

Programme of work to be pursued . . . during the year 1887. 1 p. $22^{cm} \times 35^{cm}$. [Washington, 1887.]

Also: Sid. mess., 6: 165.

Refraction tables, U. S. naval observatory, 1887. [Arranged by J. R. Eastman.] 37 p. 4to. Washington, 1887.

Report of the superintendent . . . for the year ending June 30 [Oct. 5], 1887. 17 p. 8vo. Washington, 1887.

Results of meteorological observations made at the U. S. naval observatory during the year 1883. 21 p. 4to. Washington, 1887.

Uranus.

LAMP (J.) [Observations of physical appearance in June, 1887.] Astron. Nachr., 118: 146.

VALENTINER (W.) Über die Abplattung des Uranus. Astron. Nachr., 116: 329.

Variable star. *Algol.*

BARR (J. M.) [Explanation of the variability of Algol.] Obsry., 10: 320, 388, 423.

MONCK (W. H. S.) [Cause of the variability of Algol.] Obsry., 10: 357, 425.

PARKHURST (H. M.) The variable star Algol. Sc. Am., 56: 247.

Variable star—*Continued.*

Andromedæ (Nova, 1885). *See*, Nova Andromedæ.

28 *Andromedæ.*

Backhouse (T. W.) [Variability of 28 Andromedæ.] Obsry., 10: 143, 274.

ε Aquilæ.

Lynn (W. T.) Variability of ε Aquilæ. Obsry., 10: 194.

50 *Aquilæ.*

Sawyer (E. F.) A new short-period variable in Aquila. Astron. jour., 7: 22, 87.

R *Canis majoris.*

Chandler (S. C.) jr. On the two new Algol-type variables Y Cygni and R Canis majoris. Astron. jour., 7: 144, 150.

Sawyer (E. F.) On a new variable of the Algol type. *Ibid.*, 119.

Cassiopeia.

Espin (T. E.) New variable star in Cassiopeia. DM. + 47°, 194. Astron. Nachr., 116: 271, 319.

P *Cygni* (*Nova* 1600).

Lohse (J. G.) [Observations of *nova* Cygni, 1885, Sept. 1—1886, Aug. 2.] Month. not., 47: 494.

X *Cygni.*

Chandler (S. C.) jr. A new short-period variable in Cygnus. Astron. jour., 7: 82.

—— Observations of X Cygni. *Ibid.*, 159.

Y *Cygni.*

Chandler (S. C.) jr. A new variable of the Algol type. Astron. jour., 7: 40, 47.

—— On the two new Algol-type variables Y Cygni and R Canis majoris. *Ibid.*, 144, 150.

Sawyer (E. F.) On the new Algol-type variable Y Cygni. *Ibid.*, 116.

—— Period of the Algol variable Y Cygni. *Ibid.*, 133.

Cygnus.

Espin (T. E.) [New variable in Cygnus. DM. + 38°, 3957.] Astron. Nachr., 117: 287.

DM. + 3°, 766.

Boss (L.) Variability of DM. + 3°, 766. Astron. jour., 7: 125.

ζ Geminorum.

Reed (W. M.) [Observations 1887, Feb. 10—May 14.] *Ibid.*, 127.

U *Geminorum.*

Baxendell (J.) jr. Note on recent maxima of U Geminorum. J. Liverp. astron. soc., 5: 114.

S *Hydræ.*

Sawyer (E. F.) [Observations 1887, Mar. 17—May 16.] Astron. jour., 7: 84.

Variable star—*Continued.*

Lalande 10063.

Porter (J. G.) [Observations 1885, Feb. 2—1886, Feb. 8.] Obsry., 10: 233.

White (E. J.) [Observations 1886, May 31—Nov. 22.] *Ibid.*, 159.

Libra.

Bauschinger (J.) Neuer Veränderlicher in Libra. Astron. Nachr., 118: 27.

Monoceros.

Sawyer (E. F.) [Max. and min. of T and U Monocerotis observed in 1886.] Astron. jour., 7: 109.

U *Ophiuchi.*

Chandler (S. C.) jr. Investigation of the light variations of U Ophiuchi. *Ibid.*, 129, 137.

Sawyer (E. F.) Observations 1885, 1886. *Ibid.*, 6, 82.

Orionis (*Nova*, 1885).

Monck (W. H. S.) [Possible explanation of variability.] Obsry., 10: 69.

Müller (G.) Über den Gore'schen Stern bei χ' Orionis. Astron. Nachr., 116: 119.

Parkhurst (H. M.) [Observations 1886, Oct. 22—Dec. 2.] Astron. jour., 7: 30.

Sawyer (E. F.) [Observations 1885, Dec. 19—1887, Jan. 27.] *Ibid.*, 64.

Stroobant (P.) [Observations . . . 1885, Dec. 19—1886, May 8.] Astron. Nachr., 116: 187.

Puppis.

Williams (A. S.) A new variable in Puppis. Month. not., 47: 91.

10 *Sagittæ.*

Gore (J. E.) [Observations 1886, Jan. 6—Sept. 27.] Month. not., 47: 267.

Reed (W. M.) [Observations 1886, Oct. 20—Dec. 29.] Astron. jour., 7: 85.

Sawyer (E. F.) On the variable star F. 10 Sagittæ. *Ibid.*, 102.

57 *Sagittarii.*

Sawyer (E. F.) A new variable of short period. Astron. jour., 7: 3, 29.

θ' *Tauri.*

Espin (T. E.) New variable star in Taurus. Astron. Nachr., 116: 175. *Also:* Obsry., 10: 110.

51 *Ursæ majoris.*

Gemmill (S. M. B.) Suspected new variable in Ursa major. J. Liverp. astron. soc., 5: 147.

T *Vulpeculæ.*

Chandler (S. C.) jr. Light variations of Sawyer's variable in Vulpecula. Astron. jour., 7: 1.

Variable stars.

Baxendell (J.) Maxima and minima of variable stars observed during the year 1886. Obsry., 10: 261.

Chandler (S. C.) jr. On the methods of observing variable stars. 15 p. 12mo. [Cambridge, 1887.]

Variable stars—*Continued.*

DETAILLE (C.) Méthode d'Argelander pour l'observation des étoiles variables. L'Astron., 6: 288–292.

ESPIN (T. E.) [Note on a new class of variables.] Astron. Nachr., 118: 103.

——— Stellar variation: a chapter in the world's history. *Abstr.:* J. Liverp. astron. soc., 5: 1–4.

GORE (J. E.) Some suspected variable stars of the Algol type. *Ibid.*, 108.

——— Classification of the variable stars. *Ibid.*, 23.

PARKHURST (H. M.) [Explanation of] temporary stars. Sid. mess., 6: 118.

PICKERING (E. C.) Observations of variable stars in 1886. Proc. Am. acad. arts & sc., 22: 380–395. *Also*, Reprint.

——— Proposed index to observations of variable stars. Astron. Nachr., 117: 167. *Also:* Month. not., 47: 443. *Also:* Obsry., 10: 301.

PLASSMANN (—) Die veränderlichen Sterne und die Weltbildungslehre. Sirius, 20: 65, 85.

SAWYER (E. F.) Observations of variable stars in 1885. Astron. jour., 7: 49–52.

——— Same. 1886. *Ibid.*, 155.

Venus.

LAMP (J.) [Observations of dark part, 1887, Oct. 21.] Astron. Nachr., 118: 145.

LOHSE (J. G.) Physical appearance, 1886, Jan. 2, Feb. 3.] Month. not., 47: 495.

Venus (Satellite of).

LYNN (W. T.) Montaigne's alleged observation of a satellite of Venus in 1761. Obsry., 10: 73.

STROOBANT (P). Étude sur le satellite énigmatique de Vénus avec les textes originaux relatant les observations de cet astre. 48 p., 3 pl. 4to. Bruxelles, 1887.

Repr. from: Acad. roy. de Belg. Mem. cour., 49.
Also, abstr.: L'Astron., 6: 452–457.

Venus (Transit of). *See, also,* Parallax (Solar).

AUWERS (A.) Venus-Durchgänge 1874 und 1882. Bericht über die deutschen Beobachtungen . . . 4. Bd. Heliometrischen Arbeiten zur Vorbereitung der Expeditionen und zur Untersuchung der benutzten Instrumente. 10 + 666 p. 4to. Berlin, 1887.

——— [Report of German commission for 1886.] Vrtljschr. d. astron. Gesellsch., 22: 85–89.

BOUQUET DE LA GRYE (J. J. A.) Mesure des plaques photographiques du passage de Vénus sur le soleil de 1882. Compt. Rend., 104: 550.

CRULS (L.) Observação da passagem de Venus em 1882, pelas commissoes brazileiras. Rev. d. obsrio., 2: 167.

——— Observation du passage de Vénus en 1882. [703] p. il. 4to. Rio de Janeiro, 1887.

Venus (Transit of)—*Continued.*

JOHNSON (S. J.) Observing weather during the transit of Venus [1882]. Obsry., 10: 302.

OBRECHT (J. A.) Application d'une nouvelle méthode de discussion aux résultats obtenus par les missions françaises. Compt. Rend., 105: 1004–1007.

Report of the committee appointed by the British government to superintend the arrangements . . . for the observation of the transit of Venus, 1882, Dec. 6. 88 p. 4to. [London, 1887.]

Vienna observatory.

Annalen der k. k. Universitäts-Sternwarte in Wien (Währing). Hrsg. von E. Weiss. 4. Bd., 1884. 172 p. 4to. Wien, 1886.

Vienna observatory (Wien-Ottakring).

HERZ (N.) Mittheilungen über die von Kuffner'sche Sternwarte in Wien-Ottakring. Astron. Nachr., 118: 113.

Wagner (August) [1828–1886].

STRUVE (O.) [Biographical sketch, with portrait.] Vrtljschr. d. astron. Gesellsch., 22: 2–6. *See, also,* Astron. Nachr., 115: 335.

Washburn observatory.

Publications of the Washburn observatory of the university of Wisconsin. v. 1–4. 4 v. 8vo. Madison, 1882–86.

Rev. by Valentiner (W.) Vrtljschr. d. astron. Gesellsch., 22: 24–34. *See, also, Ibid.,* 259.

Publications . . . vol. 5. 4 + 262 + 28 p. 8vo. Madison, 1887. (M. 7.50.)

Windsor observatory (Tebbutt's).

TEBBUTT (J.) History and description . . . 74 p. il. 8vo. Sydney, 1887.

Yale college observatory.

Transactions of the astronomical observatory of Yale university, vol. 1, pt. 1. Determination of the relative positions of the principal stars in the group of the Pleiades. By W. L. Elkin. 105 p. 4to. New Haven, 1887.

Zodiacal light.

SEARLE (A.) The luminous bands visible in and near the zodiac. Astron. Nachr., 116: 323.

Zürich observatory.

WOLF (R.) [Report for 1886.] Vrtljschr. d. astron. Gesellsch., 22: 163–165.

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RECORD OF SCIENCE FOR 1887 AND 1888.

ASTRONOMY FOR 1887, 1888.

By WILLIAM C. WINLOCK.

The following record of the progress of Astronomy during the years 1887 and 1888 is presented in essentially the form adopted by Professor Holden in 1879. It is thought that this form is most suitable for an annual record, as it furnishes a series of reference notes for those especially interested in the study of astronomy, and at the same time a condensed review for the general reader.

The writer has made free use of reviews and abstracts which have appeared in the Bulletin Astronomique, the Observatory, Nature, the Athenæum, and other periodicals.

COSMOGONY.

Dr. Carl Braun, S. J., formerly director of the Kalocsa Observatory, has collected in a book of 167 pages a series of essays, first published in the Catholic periodical Natur und Offenbarung in 1885–'86, in which he enters into a scientific discussion of the evolution of the universe, more particularly the formation of the sun and planets. His theory demands a structureless, motionless, tenuous nebula, its particles endowed with gravity and atomic repulsion. Such a nebula, if perfectly homogeneous, should give birth to one portentous solitary sun. But, in point of fact, it would possess innumerable, almost imperceptible, local irregularities, which, forming so many centers of attraction, would eventually lead to the breaking up of the nebula into a vast multitude of separate fragments. On one of these, the destined progenitor of the solar system, we are asked to concentrate our attention. The manner of its development is, however, a widely different one from that traced by Laplace, who assumed the needful rotation and left the rest to work itself out spontaneously. Dr. Braun, on the other hand, assumes less to begin with, but invokes adventitious aid in emergencies. He ascribes the rotation of the original solar nebula to the impact of masses drawn in from the depths of space, comet-like projectiles, endowed with energy external to the system. These masses would affect the outer shell constituting the nebula more than they would the inner, and the result is a central condensation surrounded by an ellipsoidal atmosphere revolving with increasing velocity as we proceed outwards from the center. Instead of supposing that the planets are formed from rings detached from this nebula by over-spinning, Braun assumes that their formation is determined simply by centers of condensation which existed in the nebula itself. These formations have commenced at distances from the central nucleus much greater than the present distances of the planets, and the immediate result is an approach to the sun within a distance at which its attraction is balanced by the outward gaseous pressure and the centrifugal force. The incipient planet, animated with the greater angular velocity of the stratum to which it originally belonged, revolves now at a rate slightly superior to that of the new medium in which it finds itself. Hence the possibility of its sweeping up and annexing fresh matter as it proceeds along the coils of its narrowing orbit, until a point is reached when the planet, or even sun, has drawn in all the matter which stood in its way, and gravity alone exactly balances centrifugal force. The planet then revolves in an orbit sensibly the same as at present.

As the planet in approaching the sun has encountered strata of increasing density, so that the tangential resistance on the side towards the sun has always been greater than on the opposite side, it is easy to see that a planetary or "direct" rotation must be set up in the direction of revolution. In order to explain the rotation of Neptune, which is probably, like its satellite, retrograde, it is necessary to suppose that the birth of the planet was preceded by the formation of a ring, while Uranus is regarded as a "limiting instance" between the annular and the nuclear methods of generation.

Ingenious explanations are derived for the rapid motion of Phobos, the inner satellite of Mars, for the swifter rotation of the larger planets, and for the increase in their density and decrease in their mass as we approach the sun. Mars is an exception; but there are reasons for thinking it of later formation, so that when it came into existence the space allotted for its growth was already greatly exhausted, owing chiefly to the powerful attraction of Jupiter.

While many of Father Braun's conclusions will not be accepted by cosmogonists, his work forms an able contribution to the subject. Its appearance may be said to mark the definite abandonment by sound thinkers of the annular method of planet and satellite formation, and gradually it is becoming clear that "while the various members of the solar family owned unquestionably a common origin, they can scarcely be said to have had a common history."

Janssen delivered an interesting discourse bearing upon the same subject at Paris, October 25, 1887—"The age of the stars," in which he reviewed the steps leading us to the belief that each star must have a beginning, a period of activity, a decline, and an end; and he points out that upon the hypothesis that stars of higher temperature will last longer than stars of lower, we must conclude, from the testimony of the spectroscope, that Sirius, Vega, and the greater number of the stars visible to the naked eye are in their youth, while Aldebaran, Arcturus, and our own sun have long since passed their period of greatest activity.

NEBULÆ AND STAR-CLUSTERS.

Dr. Dreyer's new general catalogue of nebulæ and clusters of stars is essentially a new edition of Sir John Herschel's catalogue, revised, corrected, and brought down to December, 1887. It therefore forms a complete list of all known nebulæ, and is of the greatest value to observers. Herschel's General Catalogue was published in 1864 and contained 5,079 objects. D'Arrest's work, published three years later, gave the means of correcting many of the errors in the earlier observations, and in 1876 Dr. Dreyer compiled a supplement from the material at that time available. Recent discoveries have given rise to a demand for a second supplement which has been wisely met by recasting the whole work. The present catalogue contains 7,840 objects, the positions being given in right ascension to seconds of time and in declination to tenths of a minute of arc. The epoch of the first general catalogue and of D'Arrest's final positions—1860—has been retained; precessions are given for 1880. There is an index to published figures of nebulæ and clusters, and an appendix giving the places of new nebulæ published too late to be incorporated in the catalogue itself. Further additions in numbers or in accuracy of positions might, perhaps, now be made from the recently published lists of Bigourdan, von Engelhardt, Ginzel, Stone, and Swift.

The largest refractor devoted almost exclusively to the observation of nebulæ is the 26-inch equatorial of the Leander McCormick Observatory. Professor Stone's object is to obtain as accurate positions as possible and thus to establish the means of detecting the proper motion of these objects if any exists. His working list embraces all nebulæ north of —30° which are as bright as the fourteenth magnitude.

Dr. Dreyer has submitted to a rigid examination all reported cases of variability or proper motion in nebulæ, and concludes that in not one case can either be considered as well established. It seems that the only well-authenticated changes are changes of brightness only, while we so far do not possess any clear evidence of change of form or change of place.

Detection of new nebulæ by photography.—Professor Pickering in order to test the efficacy of photography in the discovery of new nebulæ has compared the number of nebulæ shown in a series of photographs of the regions about the great nebulæ in Orion with the number in the same region given by Dreyer's catalogue. The instrument employed was the Bache telescope, which has a photographic doublet with an aperture of 8 inches and focal length of 44 inches. Each plate covered a region 10 degrees square, the great nebulæ being about the center;

the definition was good in a central circular area about 7 degrees in diameter. Fourteen of the objects photographed are contained in Dreyer's catalogue; four in the catalogue are not photographed; twelve that are photographed are not in the catalogue. Professor Pickering concludes that in carrying out the same proportion we might expect to discover four or five thousand such objects by photographing the whole sky; but, he adds, "there is one consideration that may seriously modify this conclusion. The successive improvements in photography have continually increased the limits of the nebula in Orion. These plates show that it not only includes the sword-handle, *c*, ι, and θ, but a long nebulosity extends south from ζ, others surround this star, while others, both north and south, indicate that perhaps the next increase in sensitiveness of our plates will join them all in a vast nebula many degrees in length."

Herr von Gothard has obtained extraordinary results with a 10-inch reflector. His photographs, though small, show a great richness of detail; several of them are reproduced in an article by Dr. Vogel, in No. 2854 of the Nachrichten. The photographs of clusters Dr. Vogel was able to enlarge without great difficulty, but for the nebulæ it was necessary to resort to drawings; among the latter the reproduction of a photograph of the spiral nebula in Canes Venatici is particularly interesting.

The Ring Nebula in Lyra.—Professor Holden reports that nearly all the nebulæ examined with the 36 inch Lick telescope show a multitude of new details of structure. In the Ring Nebula in Lyra, for example, Lassell's 4-foot reflector and the Washington 26-inch refractor show thirteen stars in an oval outside the ring, and only one star within it, while the Lick glass shows twelve stars within the ring or projected on it, and renders it obvious that the nebula consists of a series of ovals or ellipses—first the ring of stars, then the outer and inner edges of the nebulosity; next a ring of faint stars round the edges of the inner ring, and last a number of stars situated on the various parts of the nebulosity and outer oval.

Mr. Roberts' photographs of the Ring Nebula in Lyra, the Great Nebula in Andromeda, and others, also require special mention.

The Great Nebula in Orion.—In the spectrum of this nebula, Dr. Copeland has observed a new line apparently identical with D_3, wave-length 587.4. The occurrence of this line in the spectrum of a nebula is of great interest as affording another connecting link between gaseous nebulæ and the sun and stars with bright-line spectra, especially with that remarkable class of stars, of which the first examples were detected by Wolf and Rayet in the constellation Cygnus.

The Pleiades.—The initial volume of publications of the Yale Observatory is a valuable memoir by Dr. W. L. Elkin on the positions of the principal stars in the Pleiades as determined with the new Yale heliometer, and it is, we believe, the first heliometer work done in this country. Dr. Elkin has taken in all the stars in the Durchmusterung down to 9.2 magnitude, which may reasonably be said to fall within the group, and in so doing he has rejected one of the stars used by Bessel in his celebrated work with the Königsberg heliometer as too faint for accurate measurement, but he has added seventeen stars to Bessel's list of fifty-three, so that he has taken sixty-nine stars in all. Two practically independent methods of measurement were adopted. The first plan was to measure the distance of each star of the group from each one of four reference stars situated so as to form a quadrilateral symmetrically placed about the group; the position of each star thus depended on measures of distance alone. The second plan was to measure the position-angle and distance of each star from η Tauri or Alcyone, the central star of the group. The work on the quadrilateral plan was commenced in March, 1884, and lasted to December—the measures from η Tauri occupied the first three and last four months of 1885, the mean epoch of the second triangulation falling about a year later than that of the first. Dr. Elkin gives a brief description of the instrument with his method of using it, and this is followed by a determination of the instrumental constants and by the observations in detail. The definitive results are then critically compared with Bessel's heliometer work and with the filar micrometer measures of Wolf at Paris and Pritchard at Oxford. The comparison with the Königsberg observations shows that for the six largest stars there is a striking community of motion, both in direction and in amount, and it is remarkable that this general direction of drift is very similar to the reversed absolute motion of Alcyone as given by Newcomb. Dr. Elkin thinks the coincidence is sufficiently close for two of the stars at least, and possibly for the other four, to warrant the conclusion that they are only optically members of the group. Of the remaining twenty-six of the thirty-two stars showing some displacement since 1840, the epoch of Bessel's catalogue, the distribution of the direction of motion is by no means equable, six stars only having an easterly motion, while twenty move towards the west, and here too there seems to be a tendency to community of drift in certain groups in the same part of the cluster.

"The general character of the internal motions of the group appears to be thus extremely minute. If for the six stars mentioned as with more or less probability not belonging to the group this proves to be the case, there are but five stars for which the displacement amounts to over one second in forty-five years. The bright stars especially seem to form an almost rigid system, as for only one is there really much evidence of motion, and in this case (star *b*) the total amount is barely one second per century. The hopes of obtaining any clew to the internal mechanism of this cluster seem therefore not likely to be realized in an immediate future."

Professor Hall has measured with the 26 inch Washington refractor the positions of sixty-three small stars in the group relatively to the brighter stars determined by Bessel and Elkin, thus furnishing further data for testing in the future any movement that may be going on in the system.

Since the discovery of the nebula in the Pleiades around the star Maia, the Henrys have been at work perfecting their apparatus, and upon repeating their examination of the Pleiades with an exposure of four hours, and very sensitive plates, they have defined with considerable detail a great mass of cosmic matter covering a large part of the group. The most interesting detail is a straight nebulous filament 35′ to 40′ long and only 3″ to 4″ wide projecting from the main mass in an east and west direction. This filament passes over seven stars, which it seems to connect like beads on a string; a slight change in direction takes place where it meets the largest star. The plate contains nearly twice as many stars as the first plate—about 2,000 down to the eighteenth magnitude.

Excellent photographs of the Pleiades have also been taken by Mr. Roberts near Liverpool with an 18-inch silvered-glass reflector.

ASTRONOMICAL CONSTANTS.

Constant of precession.—Dr. Ludwig Struve has deduced a new value of the constant of precession and the motion of the solar system in space from an elaborate comparison of recent Pulkowa catalogues with Bradley's observations as reduced by Auwers, thus obtaining an interval of a century—1755.0 to 1855.0—for the determination of proper motions. These proper motions, computed with O. Struve's precession constant (of 1841), were affected by the apparent displacement due to the motion of the solar system in space and by the error of the assumed precession constant.

They thus furnished a means of determining these two quantities. After rejecting seven stars which seem to be exceptionally near us, the remaining 2,509 are divided into 120 groups, forming 240 equations of condition to be solved by least squares for the determination of the five unknowns, the co-ordinates X, Y, Z of the sun's "goal" (or point in space towards which the sun is traveling, to adopt the term introduced by Professor Newton) and the corrections $\triangle m$ and $\triangle n$ to Bessel's constants. The following table shows the resulting value of the luni-solar precession compared with that of previous calculators:

Bessel	50.″3635	Bolte	50.″3584
O. Struve	50. 3798	Bolte	50. 3570
Nyrén	50. 3269	Bolte	50. 3621
Dreyer	50. 3820	L. Struve	50. 3514

At the end of the paper the author treats of the planetary precession and the secular variation, and gives a list of stars whose proper motions as found by him differ from those deduced by Auwers from Greenwich and Berlin observations. The results obtained for the motion of the solar system are quoted elsewhere in this report.

Constant of aberration.—Herr Küstner of the Berlin Observatory has made a determination of the constant of aberration with a 4½ inch broken-back, universal instrument, employing what is commonly known in this country as Talcott's method. His result is a correction of $-0''.132$ to Struve's constant of aberration with the small probable error of $\pm 0''.011$. A further exhaustive discussion of the observations has led the author to conclude that the latitude of his instrument in the spring of 1884 was $0''.204 \pm 0''.021$ greater than in the spring of 1885—important evidence upon the mooted question of the variability of terrestrial latitudes.

Professor Hall has recently reduced a series of observations of α Lyræ made with the prime vertical instrument at the U. S. Naval Observatory between the years 1862 and 1867. These observations had been designed to give corrections to the assumed values of the constants of nutation and aberration, and an absolute determination of the parallax of the star. The series was not continued for a sufficient period for the first purpose, and a preliminary examination having shown that a negative parallax would result, the work has been set aside till the present time. The mean resulting parallax from the 436 observations is $\pi = -0''.079 \pm 0''.0134$, and the constant of aberration $= 20''.4506 \pm 0''.0142$.

On account of the uncertainty in the parallax, Professor Hall has introduced a parallax of $+0''.15$, about the mean value indicated by numerous observations of this star, and he then obtains a constant of aberration $= 20''.4542 \pm 0''.0144$. To this result he gives the preference and deduces for the solar parallax $8''.810 \pm 0''.0062$, adopting Hansen's value of the mean anomaly of the earth and eccentricity, Clarke's value for the equatorial radius of the earth, and Michelson and Newcomb's determination of the velocity of light, 186,325 miles per second.

Herr Nyrén has found in a discussion of the Pulkowa observations of the difference of right ascension between Polaris and its companion, evidence to confirm the hypothesis, upon which determinations of the aberration constant rest, that the velocity of light is independent of the state whether of motion or rest of the luminous body.

On the other hand the experiments of Michelson and Morley seem to throw some doubt upon Fresnel's hypotheses that the ether is at rest except in transparent media, and that there it participates in the motion of translation in the ratio $\frac{n^2-1}{n^2}$, n being the index of refraction.

Loewy's method of determining the constant of aberration from differential measurements of the changes in the distances of suitably-chosen pairs of stars is to be tested at the Paris Observatory with an equatorial coudé, and by Professor Comstock at the Washburn Observatory with suitable apparatus fitted to the 6-inch equatorial. The method is essentially to bring the two stars, which may be, say, 90 degrees apart in the sky, into the field of an equatorial by reflection from the surfaces of a double mirror at the objective: any change in the distance between the two stars can then be measured with extreme nicety. It should perhaps be mentioned that Houzeau claimed to have suggested this principle in 1871.

Diurnal nutation.—M. Niesten, in applying Folie's formulæ for diurnal nutation to the Greenwich observations of γ Draconis, has found a positive parallax where Main and Downing obtained a negative value, and a constant of aberration more closely agreeing with that generally adopted. Introducing similar corrections in Hall's discussion of the prime vertical observations of α Lyræ has, however, had no appreciable effect.

STAR-CATALOGUES AND CHARTS.

Paris Catalogue.—The first two volumes of the great work undertaken by Leverrier a third of a century ago, the re-observation of the stars of Lalande's catalogue, have recently been published. The first volume is the first installment of the catalogue proper, viz, stars from 0^h to 6^h of right ascension, observed during the years 1837 to 1881; the second volume gives the separate observations. Each series when complete will extend to four volumes. The observations were made with the five meridian instruments of the Paris Observatory, and include some 20,000 or 30,000 observations made between 1837 and 1854; they have therefore been divided into three periods, 1837-'53, 1854-'67, and 1868-'81, and severally reduced to the mean epochs 1845, 1860, or 1875. Observations subsequent to 1881, about one-fourth of the entire number, will be published separately. The present section of the catalogue contains 7,245 stars, and represents about 80,000 observations in both elements. It gives for each of the three periods the number of observations, the mean date, the right ascension and north polar distance reduced to the mean epoch, and a comparison with Lalande. The precessions for 1875 are also added. The introduction, by M. Gaillot, who has superintended the reduction, contains a discussion of the probable errors of the observations, and is followed by a comparison of the present catalogue with Auwers' Bradley, and an important investigation by M. Bossert of the proper motions of a large number of stars, followed by a table of errors in Lalande's catalogue which the present and other catalogues have brought to light.

Cincinnati Zone Catalogue.—Professor Porter has published the results of observations made with a 3-inch transit instrument, at the Cincinnati Observatory, upon 4,050 stars between the declinations $-18° 50'$ and $-22° 20'$, during the years 1885 to 1887. The faintest stars were of about 8.5 magnitude, and nearly all the stars were observed three times. The observations were made in zones, the telescope being clamped. The transits which were recorded by the chronograph were generally taken over five wires, and two bisections were made in declination whenever time allowed. The probable errors of a single observation are $\pm\ 0^s.123$ and $\pm\ 1.''81$. An appendix gives the proper motion of seventy-five stars deduced from a comparison with other catalogues.

Dunsink Catalogue.—The sixth part of the Dunsink observations is devoted to a catalogue of 1,012 stars, between —2° and —23° declination, observed with the meridian circle from 1881 to 1885. The standard stars employed are those of the Berlin Jahrbuch, and the observations are reduced to Auwers' system. The mean right ascensions and declinations, with the annual precessions for the epoch 1885.0, the mean epoch, and the number of observations are given.

Pulkowa.—Volume XII contains a catalogue for 1865.0 of the principal stars, to the fourth magnitude—381 in number—as far as 15 degrees south declination deduced from observations in the years 1861–1872. The formation of a catalogue of these stars for the epoch 1845.0 was the first piece of work completed by this observatory, and the present work is thus enhanced in value by being an almost exact repetition of that undertaken twenty years before.

Auwers' new reduction of Bradley.—The third volume of Auwers' new reduction of Bradley, which has been five years in going through the press, was finally published in 1888. This volume contains, in addition to the catalogue proper, tables giving the quantities in the reduction to the apparent place that depend upon the star's position, and a comparison of Bradley's positions, reduced to 1865, with Berlin and Greenwich observations of about the same date. The catalogue contains 3,268 stars, and gives for each star the magnitude, right ascension, and declination for 1775.0, corrections to the *Fundamenta* of Bessels, number of observations, epoch, precessions for 1755, 1810, and 1865, proper motions, references to Greenwich catalogues, and to double-star catalogues, where the star was double, and a column of notes.

An important list of 480 stars to be used as fundamental stars for zone observations between —20° and —80° declination, is published by Dr. Auwers in the Monthly Notices for June, 1887.

Dr. C. H. F. Peters has contributed two valuable papers to the third volume of the Memoirs of the National Academy of Sciences; the first is a critical examination of all data bearing on Flamsteed's twenty-two "missing" stars, for each of which a plausible explanation is found; and the second paper is a list of corrigenda in the catalogues, O. Arg. S., Bonn VI, Weisse (1 and 2), Rümker, Schjellerup, Baily's Lalande zones, Yarnall, Glasgow, Santiago, and Geneva.

A very useful index to stars in Airy's six Greenwich catalogues not found in Flamsteed—the work of Miss Lamb—will be found in the fifth volume of publications of the Washburn Observatory.

Astronomische Gesellschaft Zones.—The following notes condensed from the reports presented at the meeting of the Gesellschaft in August, 1887, show the progress of the work at that time:

Kasan, 80°–75°.—The second volume of observations has been printed, and the reductions to 1875.0 and the formation of the catalogue have been begun.

Dorpat, 75°–70°.—Partly printed.

Christiania, 70°–65°.—Greater part printed.

Helsingfors-Gotha, 65°-55°.—Catalogue finished to the precessions; 0h ready for press.

Cambridge (Harvard), 55°-50°.—Reductions nearly completed.

Bonn, 50°-40°.—Reductions well advanced.

Lund, 40°-35°.—Two-thirds reduced to 1875.0.

Leiden, 35°-30°.—Zones printed, and precessions for catalogue partly finished.

Cambridge (England), 30°-25°.—Observations nearly complete; reductions proceeding rapidly.

Berlin, 25°-20°.—Reductions nearly finished.

Berlin, 20°-15°.—Reductions under way.

Leipzig, 15°-5°.—Observations practically finished.

Albany, 5°-1°.—In press.

Nicolaief, +1° . . . −2°.—Observations finished; reductions progressing.

Observations of zero stars for the zones −2° to −23° 10′ are in progress at Leiden, Strassburg and Karlsruhe. Two of these zones have been undertaken in the United States—9° 50′ to—14° 20′ at Cambridge and −13° 50′ to −18° 10′ at Washington.

Star-charts.—Sections III and IV of the Southern Durchmusterung charts (sheets 48, 53-63) have been published, bringing to a close that most valuable work. Professor Schönfeld has issued with these last numbers a short list of errata detected, which is reprinted in No. 2834 of the Nachrichten.

A series of charts embracing all the stars visible to the naked eye—that is, down to about the sixth and one-half magnitude—has been published by Mr. Cottam, and has been very highly complimented. There are in all thirty-six sheets, the scale being one-third of an inch to one degree of a great circle. Another useful book of the same kind is Klein's New Star-Atlas, which has appeared in both English and German editions. There are eighteen maps, containing about the same number of stars as Mr. Cottam's, and giving also all the nebulæ and clusters visible in telescopes of moderate power—a great help to comet hunters.

STELLAR PARALLAX.

Parallax of α Tauri.—Prof. Asaph Hall has published in No. 156 of the Astronomical Journal, a determination of the parallax of α Tauri from a series of observations with the 26-inch Washington equatorial, extending from October 2, 1886, to March 15, 1887. The comparison-star was an eleventh magnitude companion distant about 116″, in position angle 34°.5. The resulting values of the relative parallax are: From measures of position angle, $\pi = +0''.163 \pm 0''.0409$; and from measures of distance, $\pi = +0''.035 \pm 0''.0431$. The mean value of the parallax of α Tauri from these observations is, therefore, $\pi = 0''.102 \pm 0''.0296$.

Prof. O. Struve, using the same comparison-star, recently obtained a value nearly five times as great, namely, $\pi = 0''.516 \pm 0''.057$.

Parallax of Σ 1516.—Dr. L. de Ball, of the observatory of the University of Liège, has determined in a similar manner the parallax of the brighter component (which has a sensible proper motion) of this optically double star. From measures of position angle he finds $\pi=+0''.091 \pm 0''.013$; and from measures of distance, $\pi=+0''.112 \pm 0''.010$. The mean result is $\pi=+0''.104 \pm 0''.008$.

Parallax of Σ 2398.—A new investigation of the parallax of the double star Σ 2398 has been made by Dr. Lamp, based upon observations between May 20, 1885, and March 15, 1887. In this he not only obtains a very satisfactory confirmation of his previous value of the parallax (0″.34) of the larger star, but he is able to show that the two stars are at practically the same distance. For the principal star he finds the annual parallax equal to $0''.3520 \pm 0''.0140$; for the smaller, $0''.3548 \pm 0''.0131$; or for the mean, $0''.353 \pm 0''.014$. The magnitudes are 8.7 and 8.2, respectively, and the common proper motion about $-0^s.17$ in right ascension, and $+1''.90$ in declination annually.

Parallax of first-magnitude stars in the northern hemisphere.—Dr. Elkin has completed his heliometer measures for the determination of the parallax of the ten stars of the first magnitude in the northern hemisphere, and summarizes his results in the following table:

Star.	Parallax.	Probable error.	No. of comparative stars.	No. of observations.	Proper motion.
	″	″			″
α Tauri	+0.116	±0.029	6	64	0.202
α Aurigæ	+0.107	.047	2	16	0.442
α Orionis	−0.009	.049	2	16	0.022
α Canis minoris	+0.266	.047	2	16	1.257
β Geminorum	+0.068	.047	2	16	0.628
α Leonis	+0.093	.048	4	15	0.255
α Bootis	+0.018	.022	10	89	2.287
α Lyræ	+0.034	.045	2	30	0.344
α Aquilæ	+0.199	.047	4	16	0.647
α Cygni	−0.042	.047	4	16	0.010

The mean of the ten parallaxes gives for the mean parallax of a first-magnitude star, $+0''.089 \pm 0''.015$, a result according well with the values deduced by Gyldén (0″.084) and Peters (0″.102).

The probable errors include an estimation of the probable systematic error of the measures. They are therefore considerably larger than those generally assigned to such results, which, as a rule, only take into account the mere *casual* error of observation.

It will be seen on inspection of the table that of the ten stars six may be said to give indications of a measurable parallax, but in only two cases, α Canis Minoris and α Aquilæ, are the values in any degree remarkable, and these confirm closely results of former investigators; Auwers and Wagner having obtained $+0''.240 \pm 0''.029$ and $+0''.299 \pm 0''.038$ respectively for Procyon, and W. Struve $+0''.181 \pm 0''.094$ for Altair. On the other hand, the next two largest results, those for *α* Bootis and *α* Aurigæ, do not confirm the large values found by O. Struve, +0″.516 and +0″.305; but in the case of the former star there is a close agreement with Hall, who got +0″.102 ±0″.030, and there seems to be but little doubt that the Pulkowa value is largely in error.

Of the four stars where the parallactic displacement has been inappreciable, Arcturus, with its large proper motion of over 2″, second only to that of *α* Centauri in all of the 200 brightest stars down to the fourth magnitude, is especially note-worthy. The minuteness of the parallax is beyond doubt, depending, as it does, on five pairs of comparison stars, all in reasonable agreement, and it can not be considered as seriously at variance with the results previously obtained by Peters and Johnson, +0″.127 ±0″.073 and +0″.138 ±0″.052 respectively, when their liability to systematic error is taken into account. The Yale result for *α* Lyræ does not fall in well with those hitherto deduced for this star. If we commence at the epoch of W. Struve and neglect the earlier attempts to find the absolute parallax, we have the following list of values:

	Parallax.	Probable error.
	″	″
W. Struve, at Dorpat, 1837–'40	+0.261	±0.025
Peters, at Pulkowa, 1842	.103	.053
O. Struve, at Pulkowa, 1851–'53	.147	.009
Johnson, at Oxford, 1854–'55	.154	.046
Brünnow, at Dublin, 1868–'69	.212	.010
Brünnow, at Dublin, 1870	.188	.033
Hall, at Washington, 1880–'81	.134	.0055

from which a parallax of about +0″.17 would seem well assured. The pair of comparison stars used by Elkin are very symmetrical, and so large a value would seem incompatible with the heliometer measures.

Photographic determination of stellar parallax.—Professor Pritchard, of the Oxford University Observatory, pursuing his experimental work upon the determination of stellar parallax by the help of photography, has published the following interesting results. The last three are provisional, having been determined from only six months' observations:

	Parallax.	Probable error.
	″	″
61¹ Cygni	+0.4289	±0.0180
61² Cygni	.4353	.0152
μ Cassiopeæ	.0356	.0250
Polaris	.052	.0314
α Cassiopeæ	.072	.042
β Cassiopeæ	.187	.039
γ Cassiopeæ	< .050	.047

For comparison we may cite the following results obtained by other astronomers working with equatorials and heliometers in the usual way:

61 Cygni	Bessel, 1840	+0″.348
	Auwers, 1863	+0 .564
	Ball, 1878	+0 .468
	Hall, 1880	+0 .261
μ Cassiopeæ	Bessel	−0 .12
	Struve	+0 .342
Polaris	Lindenau	+0 .144
	Struve and Peters	+0 .172
	C. A. F. Peters	+0 .067

Professor Pritchard lays stress upon the fact that each photographic plate must be considered as carrying its own scale; and, due regard being paid to the unavoidable, though slight, variations of scale in the different plates, he is of opinion that in this delicate class of work photography will give as accurate results as any other known method.

For 61 Cygni the value given rests upon the measurement of three hundred and thirty plates, taken upon eighty-nine nights; each component was referred to four comparison stars. On each of fifty-three nights four photographic plates were taken of μ Cassiopeæ, the exposures varying from five to ten minutes. Experiments seemed to indicate, however, that sufficiently approximate results, with a great saving of labor, would be obtained by confining the observations to about five nights in each of four periods of the year indicated by the position of the parallactic ellipse. Professor Pritchard proposes to apply this method systematically to all those stars between magnitudes one and one-half and two and one-half which attain at Oxford a suitable altitude; and he hopes to obtain good results for all of these stars that have a parallax not less than the thirtieth of a second of arc.

DOUBLE AND MULTIPLE STARS.

Extension of the law of gravitation to stellar systems.—Professor Hall, in a discussion of this question in the Astronomical Journal, after a review of the various speculations upon the subject, says: "The weakness of the proof that the Newtonian law governs the motions of double stars arises from two sources. In the first place, the errors of observation have a large ratio to the quantities measured. This condition makes it difficult to compute the orbits with much accuracy, or we may satisfy the observations with very different elements. - - - The insufficiency in the data can only be removed by further observation. Since there is no theoretical difficulty in the way, the continuation of the observations of double stars and the improvement of methods of observation will, in time, give the means for the accurate determination of their apparent orbits. The theoretical difficulty in proving the law of Newton for double stars can not be overcome. But we can increase the probability of the existence of this law by determining more orbits and those that are very differently situated. If the law prove satisfactory in all cases, we shall have a probability of its universality increasing with the progress of astronomy." But, although this probability may be very great, it can not constitute a proof offering the character of experimental certainty which clothes the law of Newton itself in our planetary system.

A serious difficulty is encountered in the enormous velocities with which quite a number of stars appear to be moving through space, "run-away" Groombridge—1830, μ Cassiopeæ, β Hydri, α Bootis, and others. Some of these velocities are comparable to that of a comet in close proximity to the sun, but in most cases there is no visible object near the one in motion to which we can ascribe an attractive force, acting according to the Newtonian law, which would produce the velocity observed, unless we assume enormous masses.

An interesting article upon this subject is contributed by M. Tisserand to the Bulletin Astronomique for January, 1887.

Milan Double star observations.—Professor Schiaparelli has published, in the Milan volume 33, his first series of double star observations made at that observatory with the 8-inch refractor from 1874 to 1885. There are four hundred and sixty-five stars in his list, and in most of them the components are less than 5″ apart. In an appendix are given the mean results for a number of the closest pairs as measured with the 18-inch refractor. With this instrument he discovered that the principal star of ε Hydræ is itself a very close double, the magnitudes of the two components being 4 and 5.5, and distance 0″.2 or 0″.25. The first part of the volume contains a detailed description of the optical performance of the 8-inch refractor, a discussion of the errors of the micrometer and of the accidental errors of observation, and a very full comparison with Dembowski's measures. The differences in the determination of position angle due to the varying inclination of the line joining the two stars to the line of the observer's eyes are also investigated, but the reversion prism was not used. Professor Schiaparelli finds that his measures of distance are free from systematic errors, due to personality, but his position angles have a tendency to be small as compared with those of other observers.

Professor Hough has published a catalogue of two hundred and nine new double stars discovered and measured by himself with the 18½-inch refractor of the Dearborn Observatory. Short lists of new doubles discovered with the McCormick 26-inch, and the Lick 36-inch, have also been published. Barnham's list of his discoveries with the 36-inch refractor in three months is very interesting, containing as it does new companions to γ Cassiopeæ, 11 mag., 2″.2 distant; and α Tauri, 12 mag., 2″.3 distant.

The following table contains the results of recent computations of the orbits of binary stars. The star δ Equulei is of especial interest, as the period of eleven and a half years assigned to it is the shortest of any known pair. The elements, however, are only to be regarded as provisional.

For 85 Pegasi, Mr. Schaeberle has deduced proper motions of $+0^s.833$ in right ascension, and $-1''.005$ in declination.

Elements of binary stars.

Star.	Time of periastron T	Position of node Ω	Position of periastron λ	Inclination ι	Eccentricity ϵ	Semi-axis major a	Mean motion ν	Period in years P	Computer.
		°	°	°		"	°		
δ Equulei	1892.03	24.05	26.61	81.75	0.2011	0.406	....	11.478	Wrublewsky.
β Delphini	1868.850	10.938	220.952	61.582	0.09622	0.4600	....	16.955	Celoria.
85 Pegasi	1834.00	306.1	70.3	68.6	0.35	0.96	......	22.3	Schaeberle.
Σ 3121	1878.5198	24.847	129.454	75.436	0.30863	0.67254	....	34.618	Celoria.
O . 298	1882.857	2.130	21.899	65.847	0.58360	0.88349	....	56.653	Celoria.
70 (*p*) Ophiuchi	1807.65	120.1	171.8	58.5	0.4912	4.50	−4.098	87.84	Gore.
14 (*i*) Orionis	1959.05	99.6	302.7	45.0	0.2465	1.22	−1.89	190.48	Gore.
Σ 1757	1791.98	87.6	185.4	40.9	0.4498	2.05	+1.30	276.92	Gore.
p Eridani	1823.55	135.0	240.0	38.5	0.674	6.96	−1.19	302.37	Gore.
λ Ophiuchi	1787.9	105.5	152.5	38.1	0.4424	1.53	+0.9638	373.5	Glasenapp.
Σ 948	1716.0	166.5	93.6	46.0	0.229	1.64	−0.741	485.8	Gore.

The multiple star ζ Cancri.—Professor Seeliger's recent investigations have confirmed the results of his earlier work, and those obtained by Struve in 1874. "The three stars A, B, and C have the magnitudes respectively, 5.0, 5.7, and 5.3. The proper motion of the system amounts in a century to $+10^s.6$ in right ascension, and to $-11''$ in declination. The close pair, A and B, have a motion round each other in about sixty years, their apparent distance varying from about $0''.6$ to $1''.1$; whilst C, the more distant companion, has moved through about 55° of position angle round the other two since Herschel's observations in 1781, its distance never very greatly varying from $5\frac{1}{2}''$. The motion of A and B round their common center of gravity does not appear to be disturbed to any appreciable extent by the influence of C, which is so placed as not to affect their apparent relative motions, even though a very considerable mass be assigned to it, and as a fact Professor Seeliger finds, for the most probable value of the mass of C, $\frac{m'}{1+m}=2.386$, where 1, m, and m' are the masses of A, B, and C respectively. But there is a periodical retrogression of C itself which is most easily accounted for by supposing the presence of a close companion, one hitherto undetected, and therefore either entirely dark or but faintly luminous. The distance of this companion is probably only a few tenths of a second, the distance of C from the point, s_2, round which it appears to revolve, and which may reasonably be assumed to be the center of gravity of itself and of D, the as yet undiscovered fourth member of the family, being only about one-fifth of a second. The entire group may then be considered as a double double.

VARIABLE AND COLORED STARS.

Chandler's catalogue of variable stars.—The most important work upon variable stars since Schoenfeld's "Zweiter Catalog," now thirteen years old, is a new catalogue published by Mr. S. C. Chandler as Nos. 179 and 180 of the Astronomical Journal. In the absence of any later catalogue from Schoenfeld this immediately takes its place as the standard, though the author states that it is preliminary to a more complete catalogue which will embody a series of observations and definitive investigations now in hand.

An analysis of the catalogue shows that of the 225 stars comprised in it 160 are distinctly variable; in 12 the periodic character is rather uncertainly defined; 14 are distinctly irregular; 12 belong to the so-called *novæ*, or have been seen at only one appearance; and the 27 remaining have been too little observed for the character of the variation to be properly known. Of the 160 periodical variables, epochs of both maximum and minimum are assigned for 63; maximum epochs alone for 82; minimum epochs alone for 14, 9 of these being of the Algol type, while in one the period alone is given. The elements of 124 stars are the results of Mr. Chandler's own investigations; 22 are taken from Schoenfeld; and 14 from other computers after Mr. Chandler had carefully confirmed them. The systematic perturbations shown by many of the periods have received attention, and the further study of this subject promises important additions to our knowledge of the causes of stellar variation.

A useful novelty introduced in numbering the stars calls for unqualified approval. Instead of giving them consecutive numbers each is distinguished by a number equal to one-tenth of the right ascension expressed in time-seconds for the equinox 1900.0. In this way the numeration need not be disturbed by fresh discoveries.

The catalogue gives in successive columns a serial number assigned in the way just described; Schoenfeld's number; the right ascension and declination for 1855, and the annual variations; the discoverer; date of discovery; redness on an arbitrary scale; magnitude at maximum and at minimum; Greenwich mean time of maximum and minimum; period; remarks; and approximate place for 1900.

A very ingenious method of estimating the colors was employed by Mr. Chandler; it consists in estimating the relative change in brightness effected in two stars by the interposition, first, of a blue and then of a red shade glass. If a red and a white star appear of the same brightness, when viewed directly, the red star will seem the fainter when the blue glass is interposed, but the brighter with the red glass; and these differences of brightness can be very precisely estimated by Argelander's method, and they thus afford definite measures of the differences in color of the two stars on an arbitrary scale depending upon the glasses employed. Mr. Chandler finds that the effect of brightness upon the scale-estimates is imperceptible, at least between the second and ninth magnitudes. An important result of his observations is the intimate connection shown between the length of period and the depth of color of the star; the very short-period variables are nearly white; those of longer period somewhat redder, the tint growing deeper, the longer the period.

Several new variable stars have been detected by Chandler, Sawyer, Espin, and others, and among them are two of more than ordinary interest, as they apparently belong to the well-known "Algol-type." The first was discovered by Mr. Chandler in the constellation Cygnus (Y Cygni), right ascension $=20^h\ 47^m.5$; declination $=+34°\ 14'$ (DM. + 34°, 4181). Its light varies from 7.1 magnitude to about 7.9 magnitude, and the period is probably $1^d\ 11^h\ 56^m\ 48^s$. The second star referred to, was discovered by Mr. Sawyer in March, 1887, in the constellation Canis Major, and as it is the first undoubted variable found in that constellation, it will probably be known as R Canis Majoris. Its position for 1887 is right ascension $=7^h\ 14^m.4$; declination $=-16°\ 11'$. The minimum observed by Mr. Sawyer was 6.7 magnitude, and the period is $1^d\ 3^h\ 15^m\ 55^s$. Mr. Chandler has collected the observations of U Ophiuchi, of all variables the one with shortest period and the most rapid fluctuations of light, and he finds a curious but well-marked retardation in the increase of brilliancy some half-hour or so after minimum is passed. A similar irregularity has been noticed in the light-curve of S Cancri and occasionally in that of Algol.

Mr. Chandler strongly urges the possessors of large refractors to devote a portion of their time to the observation of the minima of variables that become too faint for ordinary telescopes, our knowledge of such variables being extremely deficient. Argelander's method of observation is recommended.

Professor Pickering has in preparation an index to observations of variable stars which will give for each star the number of observations each year since the discovery of variability. This index will be published in volume 18 of the Annals of the Harvard Observatory.

In an interesting article published in the Observatory (April, 1888), Miss Clerke has collected a series of notes upon variable double stars. These stars show for the most part a spectrum analogous to that of Sirius, that is of Class I, although single stars of that class hardly ever show any fluctuations in brightness. Algol-variables, if the eclipse theory of their changes be admitted, make no exceptions to this rule; Gore's catalogue contains three examples: δ Orionis, S Monocerotis, and Y Virginis, and among the well-known doubles are γ Virginis, ζ Bootis, π Bootis, 38 Geminorum, α Piscium, θ Serpentis, and β Scorpii, and perhaps δ Cygni. With few and doubtful exceptions, revolving double stars vary in concert, if they vary at all. The changes of γ Virginis illustrate the mode of procedure in this respect of couples intrinsically equal. They alternate in each component, and can thus be detected only by close attention. Each may be described as normally of the third magnitude; and each in turn declines by about half a magnitude and recovers within a few days, yet so that the general preponderance, during a cycle of several years, remains to the same star. Miss Clerke suggests that simultaneous variation in the color of neighboring stars may lead to the discovery of their physical dependence.

Mr. G. F. Chambers has prepared a catalogue (still in manuscript) of seven hundred and eleven red stars, brighter than the eight and one-half magnitude, the result of observations made from 1870 to 1886; less than twelve stars, according to Mr. Chambers, can properly be termed carmine or ruby.

STELLAR PHOTOMETRY.

The magnitudes of the standard stars of the British, French, German, Spanish, and American nautical almanacs have been rediscussed by Professor Pickering, and his results will probably be adopted in future issues of the French, Spanish, and American works. The plan proposed was, that the magnitude adopted for each star should be the mean of those derived from the Harvard Photometry, the photometric observations of Wolff, the Uranometria Oxoniensis, and the Uranometria Argentina. The list published embraces 800 stars, and of these the magnitudes of all but 64 depend upon at least two and generally upon three authorities; 132 stars being common to all four of the adopted standard catalogues of brightness.

A "wedge-photometer," constructed under the direction of Professor Pritchard for the Harvard Observatory, has been submitted to a careful examination by Professors Langley, Young, and Pickering, and it appears from Professor Langley's investigation of the wedge, by means of his bolometer, that there is a selective absorption of light throughout the wedge; feeble in the more luminous portion of the spectrum, but of such a character that, broadly speaking, the transmissibility always increases from the violet toward the red, increasing very greatly in the infra-red. These results have been confirmed by Professor Pickering's experiments, and they emphasize the danger, already recognized by Professor Pritchard, of employing an instrument of this kind in the observation of deeply-colored stars.

From a comparison of the star-magnitudes of the Oxford Uranometry with those of Wolff's second catalogue, and with those of the Harvard Photometry, Professor Pickering has found that the Oxford magnitudes are, on the average, less than the Harvard magnitudes for stars down to the third magnitude, but greater for the fourth and fifth, and less again for stars below the sixth. The Harvard catalogue differs less from those of Wolff and Pritchard than the two latter do from each other.

STELLAR SPECTRA.

Photographic study of stellar spectra. Henry Draper memorial.—Professor Pickering, in his annual report for 1888, presents the progress made in the various investigations of stellar spectra as follows: A catalogue has been prepared of the spectra of 10,875 stars, covering the entire sky north of −25°. The 8-inch Bache telescope has been used for this work. Six hundred and thirty-three plates have been taken, and 27,953 spectra have been examined. The type of spectrum is given in each case, and in about six thousand cases additional lines are visible and have accordingly been described. The photographic intensities of the spectra have also been measured, giving a photometric measure of the stars by which those of different colors may be compared. The first draft of a spectroscopic catalogue has been prepared, including the place of each star for 1900, its designation and magnitude in various catalogues, its photographic brightness, and the description of each spectrum. The photographs required for the second investigation on the spectra of the fainter stars are nearly completed. The instruments employed in both of these investigations were prepared for shipment to Peru, where the work will be continued among the southern constellations. The detailed study of the brighter stars with the 11-inch Draper telescope has been extended by the use of plates stained with erythrosin. The sodium line D in these spectra has thus been photographed as a double line. A catalogue has been formed of the lines in some of the brighter stars. In Sirius the lines, except those due to hydrogen, are very faint. But nearly four hundred of them have been measured in different photographs of this star; fifteen are recorded between the lines H and K. A beginning has also been made of the study of the spectra of the variable stars.

Dr. von Konkoly and his assistant, Dr. Kövesligethy, have carried the spectroscopic survey of the heavens begun by Vogel and Dunér to 15 degrees south declination, and have published their work in volume 8, part 2, of the O'Gyalla observations. The instrument used was a Zöllner spectroscope. Vogel's arrangement of types was followed. The catalogue contains in all 2,022 stars, down to 7.5 magnitude. But one bright line spectrum was suspected, a star of 6.5 magnitude 50′ north of ζ Orionis, and this star, as well as β, δ, and ε Orionis, is found to have a variable spectrum.

Among the peculiarities detected in stellar spectra may be noted the discovery by Espin on August 13, 1888, of a bright line in the spectrum of the variable star R Cygni; and as Dunér found it in 1879–'82 of a weak III type, an extraordinary change seems to have taken place. Espin's bright line was apparently of a temporary character, and faded rapidly.

Motion of stars in the line of sight.—The spectroscopic observations for the determination of the motions of stars in the line of sight have been continued at Greenwich and at the Temple Observatory, Rugby, the only two observatories that have thus far given systematic attention to this important line of work. The most interesting results are in the case of Sirius, which, when first observed at Greenwich in the winter of 1875–'76, seemed to be receding from us at the rate of 24 miles per second. This recession gradually changed to an *approach* of 5 miles per second in 1882–'83, increasing to 24 miles in 1885–'86, and then dropping to 1 mile in 1886–'87, and now becoming a recession again, in 1887, of 6 miles per second. As the Astronomer Royal remarks, these results are to be accepted with caution; the F line for which the measures were made would seem to have changed somewhat its characteristics, and the observation is moreover one of extreme difficulty, the discordances obtained on different nights being almost as great as the whole range of displacement noted.

Dr. Vogel, of Potsdam, has successfully applied photography to the determination of the displacement of lines in stellar spectra due to a motion of the star in the line of sight. Two Rutherford prisms were used, the observations being made on the third line of hydrogen, $H\gamma$. Dr. Scheiner, who has been carrying out these experiments, has examined the spectra of Sirius, Procyon, Castor, Arcturus, Aldebaran, Pollux, and Rigel. Of these, Sirius showed a slight displacement toward the red, thus indicating a motion away from us; Procyon a decided displacement, and Rigel a very large one in the same direction, while Arcturus showed a considerable displacement towards the violet. A systematic examination of all stars of the first and second magnitudes is to be undertaken with improved apparatus.

ASTRONOMICAL PHOTOGRAPHY.

The Paris International Astrophotographic Congress.—The general interest in the application of photography to astronomical observations has resulted in a meeting called by the French Academy of Sciences, at the instance of Admiral Mouchez, for the purpose of uniting upon a plan for preparing by international co-operation a photographic chart of the heavens more extensive than any hitherto attempted by the usual methods. The Congress was opened at the Paris Observatory on April 16, 1887, by M. Flourens, minister of foreign affairs of the French Government, and addresses were made by M. Bertrand, the eminent mathematician, by Admiral Mouchez, director of the Paris Observatory, and by Professor Struve, director of the Pulkowa Observatory. Fifty-six members were present, including thirty-seven foreign astronomers, representing sixteen nations. Admiral Mouchez was chosen honorary president; Struve, president; Auwers, Christie, and Faye, vice-presidents; Bakhuyzen and Tisserand, secretaries, and Dunér and Trépied, assistant secretaries. At the first meeting a committee of nineteen was appointed to consider and report upon the size and construction of the instruments to be employed, and upon the limit of star-magnitudes to be included in the photographs. This committee reported on April 19, and after some discussion it was decided to divide the Congress into two sections—one to deal with purely astronomical questions, and the other with questions pertaining to the photographic side of the problem. Each section drew up a series of resolutions which were further discussed and amended by the Congress in full session, the result being an agreement to adopt refracting telescopes of 13 inches aperture and 11¼ feet focal length, and to undertake two series of photographs of the entire sky, one taking in stars as faint as the fourteenth magnitude, the other stopping at the eleventh. The ultimate aim is to convert the positions of the stars upon these last plates into the usual co-ordinates of right ascension and declination, and to publish them in the form of a star catalogue, and to prepare from the series embracing the fainter stars a set of glass positives for each of the co-operating observatories or nations.

Following are the resolutions in detail as finally adopted:

(1) The progress made in astronomical photography demands that astronomers of the present day should unite in undertaking a description of the heavens by photograhpic means.

(2) This work shall be carried out at selected stations, and the instruments shall be identical in their essential parts.

(3) The principal objects shall be: *a.* To prepare a general photographic chart of the heavens for the present epoch, and to obtain data which shall enable us to determine the positions and magnitudes of all stars down to a certain magnitude, with the greatest possible accuracy (magnitudes being understood in a photographic sense to be defined later). *b.* To be able to utilize in the best way, both in the present and in the future, the data obtained by photographic means.

(4) The instruments employed shall be exclusively refractors.

(5) The stars shall be photographed as far as the fourteenth magnitude, inclusive; this magnitude being indicated provisionally by the scale actually in use in France, and with the reservation that its photographic value shall be definitely fixed afterward.

(6) The aperture of the object-glasses shall be 0.33 meter (13. inches), and the focal length about 3.43 meters (11¼ feet), so that a minute of arc shall be represented approximately by 0.001 meter.

(7) The directors of observatories shall be at liberty to have the object-glasses made where they desire, provided they fulfill the general conditions laid down by the Congress.

(8) The aplanatism and achromatism of the objectives shall be calculated for radiations near the Fraunhofer ray G.

(9) All the plates shall be prepared according to the same formula; this formula to be subsequently agreed upon.

(10) A permanent control of these plates from the point of view of their relative sensibility to the different radiations shall be instituted.

(11) Questions in regard to the preservation and reproduction of the negatives can not at present be settled, and shall be referred to a special committee.

(12) The same conclusions are adopted in regard to the photographic magnitudes of the stars.

(13) Resolution 8 above, in regard to the aplanatism and achromatism of the object-glasses, shall be understood in the sense that the minimum focal distance shall be that of a ray near G, so as to attain the maximum sensibility of the photographic plates.

(14) The object-glasses shall be constructed in such a manner that the field to be measured shall extend at least 1 degree from the center.

(15) In order to eliminate fictitious stars and to avoid inconvenience from minute specks which may exist upon the plates, two series of negatives shall be made for the whole sky.

(16) The two series of negatives shall be so made that the image of a star situated in the corner of a plate of the first series shall be found as nearly as possible in the center of a plate of the second series.

(17) Besides the two negatives giving the stars down to the fourteenth magnitude another series shall be made with shorter exposures, to assure a greater precision in the micrometrical measurement of the fundamental stars, and render possible the construction of a catalogue.

(18) The supplementary negatives, destined for the construction of the catalogue, shall contain all the stars down to the eleventh magnitude approximately. The executive committee shall determine the steps to be taken to insure the fulfillment of this condition.

(19) Each photographic plate to be used in the formation of the catalogue shall be accompanied by all the data necessary to obtain the orientation and the value of its scale; and, as far as possible, these data shall be written on the plate itself. Each plate of this kind shall show a well-centered copy of a system of cross-wires for the purpose of eliminating errors which may be produced by a subsequent deformation of the photographic film. Further details of this nature shall be determined by the executive committee.

(20) In the negatives intended for the map the number of cross-wires to be used in their control and reduction shall be reduced to a minimum.

(21) The tubes of the photographic instruments shall be constructed of the metal most likely to give an invariable focal plane and shall carry a graduation for the determination and regulation of the position of the plate.

(22) The executive committee shall choose the reference stars to be used.

(23) The question of the methods of measurement and the conversion of the numbers obtained into right ascensions and declinations for the equinox of 1900 is left to the executive committee. That committee shall first occupy itself with the study and methods of use of measuring-instruments, giving either rectangular or polar co-ordinates, and based upon the simultaneous use of scales for the larger distances, and micrometer screws for scale subdivisions.

(24) The connection of the plates will be effected in conformity with resolution No. 16.

At the last general session, April 25, the Congress delegated its powers to a permanent committee, consisting of the directors of the observatories actually taking part in the work, and the following eleven members chosen by ballot, viz.: Christie, Dunér, Gill, Prosper Henry, Janssen, Loewy, Pickering, Struve, Tacchini, Vogel, and Weiss. The observatories of Algiers, Bordeaux, Cape of Good Hope, Greenwich, La Plata, Melbourne, Oxford, Paris, Potsdam, Rio de Janeiro, Santiago, San Fernando, Sydney, Tacubaya, Toulouse, have been pledged to co-operate, and the instruments for several of them are well advanced. No observatory in the United States has thus far signified definitely its intention of co-operating, though the Government has been appealed to to appropriate the necessary funds for the Washington Observatory. The business of the permanent committee is transacted through an executive bureau, consisting of Admiral Mouchez, president; Christie, Dunér, Janssen, Struve, and Tacchini, members, and Gill, Loewy, and Vogel, secretaries. It is expected that meetings of the permanent committee will be held every three years, though they may be called more frequently if found desirable. Before adjourning, the Congress elected also a special committee, to occupy itself with the application of photography to astronomy other than the construction of a map, acting in concert with the permanent committee. Messrs. Common and Janssen were requested to take charge of this matter. They have communicated by circular with all who are likely to be interested in this work, and propose to call a meeting at Paris, and form a committee for the consideration of the best means of carrying out the plan suggested by the Congress.

As many preliminary experiments are necessary in arranging details, special subjects of investigation have been referred to different astronomers. For instance, the study of the proper form of reticule, to Vogel; photographic magnitudes, to Struve and Pickering; optical deformation of images, to Struve; study of three or four stars nearly in a straight line, embracing an angular distance of about 1 degree, and photographed necessarily at the center and corner of a plate, to the observatories of Algiers, Leyden, Paris, Pulkowa; distortion of the sensitive film, to Algiers, Meudon, Potsdam; curved plates, Christie; orientation of the plates, the Cape, Paris; measuring apparatus, to a special committee; formula for the preparation of the plates, Abney, Eder; the effect of colors of the stars upon the photographic magnitude, Dunér.

The permanent committee has published, through the Paris Academy, three reports: the first, a full account of the Congress held in April, 1887; the other two, "bulletins," containing correspondence and results of the preliminary investigations. These papers are of great importance in the proposed photographic work, but they can hardly be reviewed satisfactorily here. The most extensive are: "Note sur l'application de la photographie aux mesures micrométriques des étoiles, T.-N. Thiele; De l'influence des durées de la pose sur l'exactitude des photographies stellaires, J. Scheiner; Travaux préparatoires effectués à l'observatoire de Potsdam, Vogel; Exposé de la méthode parallactique de mesure,—réduction des clichés, J. C. Kapteyn; Recherches faites à l'observatoire de Harvard College sur les résultats photométriques, E. C. Pickering; Étendue du champ des clichés photographiques de l'observatoire de Paris, MM. Henry."

It is strongly recommended that the plates be measured at a central bureau established in the neighborhood of Paris.

Professor Pritchard having undertaken, for the photographic committee of the Royal Society, an examination of two silver-on-glass mirrors of the same aperture but of very different focal lengths, with a view of ascertaining the practical effects of focal length on the photographic field, has concluded that mirrors are unsuitable for any extensive charting, particularly mirrors of short focal length; at the same time there is no doubt as to their capacity for the singularly accurate delineation of small portions of the heavens, and for such operations as those connected with stellar parallax or the charting of the moon.

Mr. Roberts has described in the Monthly Notices (49: 5–13) an instrument which he calls the "stellar pantograver," intended to surmount the difficulties of reproducing the negatives after they have been obtained. It is essentially an instrument for engraving upon copper plates points of the same size and in the same relative positions as those depicted by the photographs.

In the long exposures of two hours and upwards that some of the photographs have required there is considerable danger of displacements of the images upon the plates due to variations in the refraction. Dr. Dreyer has found that in latitude +50° such displacements are not likely to exceed 0″.5 (and will therefore not affect sensibly the symmetry of the images) in the case of an equatorial star moving from 27^m east to 27^m west of the meridian or in the case of a star of +25° declination moving from 39^m east to 39^m west.

The photographic work of Professor Pickering upon stellar spectra, and of Gothard, Vogel and Roberts upon nebulæ, has been mentioned under these headings. Rapid progress has been made by Dr. Gill with his southern photographic Durchmusterung.

COMETS.

Comet Encke (1888 II).—Encke's well-known periodic comet was picked up by Mr. Tebbutt, of Windsor, New South Wales, with the help of the ephemeris of Backlund and Seraphimoff, on July 8, 1888, ten days after it had passed perihelion. In a 4½-inch telescope it appeared as a small, bright, well-condensed nebula, about 1′ in diameter, without a nucleus. It was observed at Windsor till August 1, when it was "of the last degree of faintness," and at the Cape to August 9, but it was unfavorably situated for observation in the northern hemisphere.

Berberich has discussed the brightness of Encke's comet as seen at different returns from 1786 to 1885, and calls attention to the rather remarkable circumstance that the comet has been most conspicuous when seen near a time of maximum of solar spots, and least when returning near a minimum.

Comet Faye (1888 IV).—Found by Perrotin, at Nice, August 9, 1888, by the help of a sweeping ephemeris prepared by Kreutz. It was described as a very faint, circular nebulosity about one minute in extent, with a slight central condensation. Although it remained visible as late as February, 1889, on account of its extreme faintness but few observations seemed to have been secured. Maximum brightness was reached about the beginning of December. The correction to the ephemeris computed directly from the elements was $-4^{m}.4$; $+ 4'$, corresponding to a retardation of the perihelion time of about two days.

Comet Olbers, originally discovered by the celebrated Dr. Olbers on March 6, 1815, was picked up by Brooks on August 24, 1887, indedendently of Ginzel's ephemeris. Bessel, who made a discussion of the earlier observations, predicted a return to perihelion on February 9, 1887, and Dr. Ginzel, rediscussing the orbit in a very elaborate manner, found the most probable date of perihelion to be December 17, 1886, with an uncertainty of 1.6 years. Perihelion actually occurred on October 8, 1887. Especial interest attaches to this comet as the third member of the group of comets having a period of about seventy-five years (Halley's, Pons', and Olbers'), which has returned to perihelion in conformity with prediction. Kammermann, at Geneva, described it on August 29, 1887, as a bright 7.8 magnitude, with a faint tail. There seems to be no reason for supposing that it has lost anything of its light-giving power since its previous appearance in 1815. The last observation at this return was made at the Lick Observatory on July 5, 1888, when the theoretical brightness was less than one-tenth that at the time of discovery.

Comet Tempel.—The comet discovered by Tempel on July 3, 1873, and found to have a period of five and one-quarter years, was observed at its return in 1878, but escaped observation in 1883 when it was due at perihelion on November 20. The conditions of visibility seem to be even worse for the return of 1889, the comet remaining too near the sun, while the circumstances of the return in 1894 are but little different from those of 1883.

Comet Winnecke.—Von Haerdtl has rediscussed the motion of Winnecke's comet, making use of observations at a later return than Oppolzer could employ in 1880. The object was to detect, if possible, any increase in the mean motion similar to that exhibited by Encke's comet, though not sensible in Faye's comet, possibly owing to its great perihelion distance. He finds no acceleration whatever of the mean motion, the actual figures indicating rather a slight retardation, but far too small to justify any conclusion other than absence of change in the mean motion and length of period.

Comet 1886 VIII:
=Comet *c* 1887.

Discovered by Barnard on January 23, 1887; last observed on May 22, 1887; perihelion November 28, 1886.

Comet 1887 I:
=Comet *a* 1887.
=The great southern comet.

A cable dispatch from Dr. Thome, the director of the Cordoba Observatory in South America, announced his discovery on January 18, 1887, of a large comet, or rather the tail of a large comet, faint and illusory in the twilight and mist of the horizon. From later information it appeared that the comet was seen at Blauwberg, near Cape Town, on the same evening, by a farmer and a fisherman, and a day or two later it was seen at several places in Australia. Dr. Thome was not able to confirm his discovery till January 20. From the 22d to the 25th the comet was a beautiful object to the naked eye—a narrow, straight, sharply defined, graceful tail, over 40 degrees long, shining with a soft starry light against the dark sky, beginning, apparently, without a head, and gradually widening and fading as it extended upwards. At the Cape of Good Hope it was observed from January 22 to 28, the long, straight tail recalling the comet of February, 1880. The Revista do observatorio for February, published by Dr. Cruls at Rio Janeiro, gives a sketch of the comet made on January 24. The nucleus was then somewhere beyond the bright star α Gruis, invisible in the haze of the horizon, and the tail stretched up beyond β Hydrae, a narrow ribbon 52 degrees in length and about half a degree in width. As far as we have been able to learn the comet was not seen at all in the northern hemisphere, and was not followed in the southern hemisphere beyond the end of January.

Unfortunately, also, no well-defined nucleus, or even the slightest condensation as a point of observation could be made out at any of the observatories at which the comet was visible, and from the rough observations which were obtained it is impossible to determine the orbit with any degree of precision. The earlier dispatches suggested the identity of the new comet with the great comet of 1880, apparently on the ground of a general similarity of the circumstances of the apparition, and on the fact that the line of sight nearly intersected the orbit of the comet of 1880; but Mr. Chandler, who has made a critical discussion of all the observations obtained, has been unable to reconcile them with an orbit similar to that of the group of great comets of 1843, 1880, and 1882; the orbit that he obtains bears a closer resemblance, in fact, to those of the comets of 1680 and 1689. The unavoidable uncertainty in the observations must, however, leave the question of identity unsettled. The extremely small perihelion distance is worthy of notice, and may, perhaps, account for the lack of nucleus. Indeed, if we accept the orbit computed by Dr. Oppenheim ($q=0.0047$), the comet must have ploughed through the surface of the sun itself.

Comet 1887 II:
= Comet *b* 1887.

Discovered by W. R. Brooks, at Phelps, New York, on the evening of January 22, 1887, in the constellation Draco. In the early part of February it reached its greatest northern declination, 80°, then went south again, and was last observed by Plummer at Orwell Park, on April 23. From the time of discovery it increased gradually in brightness till about the middle of February, when it was described as a bright telescopic object about 3′ in diameter with well marked central condensation of the tenth magnitude. According to the yet unfinished investigation of Dr. Stechert the orbit shows a well-marked ellipticity.

Comet 1887 III:
= Comet *d* 1887.

Discovered by Barnard at Nashville on the night of February 16, 1887, in 8^h right ascension, and 15° south declination, a very faint nebulous object with rapid motion towards the north and west; last observed on April 10, at Orwell Park. The ordinary formula for brightness, which assumes that the comet shines by reflected sunlight only, seems to have failed in this case, as in many others; in the middle of March, when its theoretical brightness was 0.12 that at the time of discovery, it was apparently as well seen as during the first days of its appearance.

Comet 1887 IV:
=Comet *e* 1887.

Barnard's third comet of 1887 was discovered at 11 o'clock on the evening of May 12, in right ascension 15^h, declination—31°. On May 13 it was described by Boss as having a star like nucleus of the 11.5 magnitude. It increased somewhat in brightness till about the middle of June, developing a tail which attained a length of 5′. It moved rapidly north, and on account of its brightness and favorable situation was well observed, till August 11. Mr. Muller has already completed a definitive orbit, and finds that the observations are represented by an ellipse somewhat better than by a parabola.

Comet 1887 V:
=Comet *f* 1887.
=Comet 1815.
=Olbers' comet.
=Olbers-Brooks comet.

Found by W. R. Brooks, of Phelps, New York, on August 24, 1887. (See comet Olbers.)

Comet 1888 I:
=Comet *a* 1888.

Discovered by Sawerthal, at the Cape of Good Hope, on February 18, 1888, or the early morning of February 19, civil reckoning, the comet being readily seen with the naked eye, with sharply defined nucleus of the seventh magnitude in right ascension 19^h, declination −56°; a tail 2° in length was visible with an opera-glass. The rapid northerly motion brought it, by the 12th of March, into view in the northern hemisphere, where it was followed until September, being reported visible to the naked eye until the first part of May. Thome, at Cordoba, described it as a fine naked-eye object, with a tail, at its maximum, 5° in length and a nucleus of three and one-half magnitude. Remarkable fluctuations occurred in the brightness of the head, during the months of March and May, resembling the phenomena noted in the great September comet of 1882 and the Pons-Brooks comet of 1884.

On the 19th of March the main eighth magnitude nucleus was seen to have an eleventh magnitude companion, and on the 27th of the month a third faint nucleus was detected; the triple nucleus was last seen on the 4th of June. Between the 19th and 21st of May it became five or six times brighter than during the days immediately preceding, and from the nucleus two bright streamers were shot out, curving backward on either side of the nucleus into the tail. This sudden outburst is all the more difficult to account for as it occurred two months after perihelion; it is to be regretted that no spectroscopic observations were obtained at this critical period. The spectroscopic observations made in March and April showed a faint, broad, continuous spectrum, in addition to the three characteristic hydrogen bands. The orbit, according to Berberich, is undoubtedly elliptic, the period, from his preliminary computation, being 2,370 years.

Comet 1888 II:
=Comet *b* 1888.
=Encke's comet.

First observed at this return by Tebbutt, at Windsor, New South Wales, on July 8. (See comet Encke.)

Comet 1888 III:
=Comet *c* 1888.

Discovered by W. R. Brooks, at the new Smith Observatory, Geneva, New York, about 8:45 P. M., August 7, 1888—right ascension $10^h 5^m$, declination +44°.30′. The head was round, one-half minute in diameter; the nucleus was of the ninth to tenth magnitude, and there was a little tail 5′ long in position angle 270°. Perihelion had been passed on July 31; the last observation reported was on October 10.

Comet 1888 IV:
=Comet *d* 1888.
=Faye's comet.

Found by Perrotin, at Nice, August 9, 1888. (See Comet Faye.)

Comet 1888 V:
=Comet *f* 1888.

Discovered by Mr. E. E. Barnard, at the Lick Observatory, on October 30; a faint suspicious object, the head well developed, with ill-defined nucleus, and a short tail. Perihelion had taken place some forty-eight days before discovery, but the increasing distance from the sun was largely compensated for by the approach to the earth, so that the comet was observed for several months in 1889.

Comet 1889 I:
=Comet *e* 1888.

This comet was discovered by Barnard at the Lick Observatory, with a 4 inch comet-seeker, on September 2, 1888, or the morning of September 3, and also independently by Brooks, at Geneva, on the following morning. It was a round nebulous mass 1′, in diameter, with a central condensation of 11–12 magnitude and no tail. At the end of November it reached its maximum brightness, twelve times as bright as at discovery, and appeared to the naked eye like a nebulous star of the sixth magnitude. It will not pass perihelion till January 31, 1889.

The spectrum, according to Dr. Copeland, on November 14, instead of being composed of the usual feeble separate bands, was continuous, rather long, extending from wave-lengths 575 to 450 of Angström's scale, brighter in the middle and fading gradually at both ends; it resembled the spectrum of a close globular star-cluster or of a non-gaseous nebula, rather than that of a self luminous gas. Faint patches of light were made out in the positions usually occupied by the second and third cometary bands. Similar observations were made later, and on December 8, all three bands were distinctly visible, but on each occasion the continuous spectrum formed the ground on which the brighter spectrum was superposed. "It seems probable that the comet shines mainly by reflected light, - - - to which the action of the sun on the cometary material is slowly adding the usual bright bands."

Approximate elements of the comets of 1887 and 1888.

Designation.	Perihelion = T Greenwich mean time.	☊	ω	i	q	e	Discoverer.	Date of discovery.	Synonym.	
	1886.	° ′	° ′	° ′				1887.		
1886 VIII	Nov. 28.38....	258 12	31 53	85 35	1.480	....	Barnard	Jan. 23	1887 c	
	1887.									
1887 I	Jan. 11.23....	337 43	63 36	137	0.005	....	Thome..........	Jan. 18	1887 a	Great Southern Comet.
II	Mar. 17.03....	279 51	159 11	104 17	1.633	....	Brooks	Jan. 22	1887 b	
III	Mar. 28.40....	135 27	36 29	139 49	1.007	....	Barnard	Feb. 16	1887 d	
IV	June 16.66....	245 13	15 8	17 33	1.394	0.996	....do..........	May 12	1887 e	
V	Oct. 8.46....	84 29	65 19	44 34	1.199	0.931	Brooks	Aug. 24	1887 f	Olbers's.
	1888.							1888.		
1888 I	Mar. 17.00....	359 55	245 23	42 15	0.699	0.995	Sawerthal	Feb. 18	1888 a	
II	June 27.99....	334 39	183 57	12 53	0.343	0.846	Tebbutt	July 8	1888 b	Encke's.
III	July 31.15....	101 30	59 14	74 12	0.902	....	Brooks	Aug. 7	1888 c	
IV	Aug. 19.54....	209 42	201 14	11 20	1.738	0.549	At Nice.........	Aug. 9	1888 d	Faye's.
V	Sept. 13.00....	137 35	291 4	56 27	1.522	....	Barnard	Oct. 30	1888 f	Elliptic?

Prof. Daniel Kirkwood has suggested that certain comets of short period may have originated within the solar system. Wolf's comet (1884 III), for example, before its last near approach to Jupiter, had an eccentricity of 0.28, which is exceeded by twelve known asteroids, and the elements of Tempel's comet (1867 II) do not differ greatly from those of an eccentric asteroid. Out of twenty short-period comets, seven have disappeared either by dissolution, like Biela's comet, or by the transformation of the orbit by Jupiter as in the case of Lexell's comet. Five, or, including Encke's and Biela's, seven, have periods commensurable with that of Jupiter; all have direct motion; all but one have a smaller inclination than Pallas, and there is a tendency of the perihelia to concentrate in the 180° (from 290° to 110°), as in the asteroids.

One of the most able of recent contributions to cometary astronomy is a monograph by Dr. Kreutz upon the orbit of the great September comet of 1882. In connection with investigations being carried on by Professor Weiss this will form a complete discussion of the system of comets with remarkably small perihelion distance, 1843 I, 1880 I, and 1882 II.

Dr. Galle is compiling a catalogue of recent comets embracing the various supplements to the list given in 1847 in Encke's edition of "Olbers' Methode."

METEORITES.

Researches on meteorites.—Mr. Lockyer presented at the meeting of the Royal Society on November 17, 1887, a paper giving the results of his "Researches on Meteorites," which has attracted much attention. He has examined meteoric spectra under various conditions, particularly that of feeble temperature, and has found it possible to obtain from meteorites spectra that show the most peculiar features of solar, stellar, nebular, or cometary spectra. "In the spectra of nebulæ, for instance, seven lines have been detected, of which three were traced to hydrogen, three to low-temperature magnesium, and the seventh, which has not yet been traced to its originating element, has been given by the glow from the Dhurmsala meteorite. The most characteristic nebular line was identified with the low-temperature fluting of magnesium, and the unusual spectrum obtained from the comets of 1866 and 1867 was ascribed to the same cause. The changes observed in the spectrum of the great comet of 1882 were such as would correspond to the changes induced by the change of temperature in the spectrum of a meteorite; and the changes in the spectrum of Nova Cygni, and the bright lines in such a star as R Geminorum received a similar explanation; while a very full, in parts almost perfect, reproduction of a considerable portion of the solar spectrum has been obtained by taking a composite photograph of the arc spectrum of several stony meteorites, taken at random between iron meteoric poles. These and similar observations have led Mr. Lockyer to regard all self-luminous bodies in the celestial spaces as composed of meteorites, or masses of meteoritic vapor produced by heat brought about by condensation of meteor-swarms due to gravity, so that the existing distinction between stars, comets, and nebulæ rests on no physical basis. All alike are meteoritic in origin, the differences between them depending upon differences in temperature, and upon the closeness of the component meteorites to one another. *Novæ* (new stars that blaze forth suddenly) are explained as produced by the clash of meteor-streams, and most variable stars are regarded as uncondensed meteor-streams. Stars with spectra like that of Alpha Orionis (Rigel) are considered not as true suns, but as mere clouds of incandescent stones; probably the first stage of meteoritic condensation. Stars with spectra of the first and second type represent the condensed swarm in its hottest stages, while spectra of Secchi's fourth type indicate an advanced state of cooling."

The general conclusions arrived at by Mr. Lockyer may be thus summarized: All self-luminous bodies in space are composed of meteorites variously aggregated, and at various stages of temperature depending upon the frequency and violence of their mutual collisions. Comets, nebulæ, bright-line stars, stars showing banded spectra of the third type, including most long-period variables, are to be regarded as veritable meteor-swarms; they are made up, that is to say, of an indefinite multitude of separate and (in a sense) independent solid bodies, bathed in evolved gases, and glowing with the heat due to their arrested motions. "The existing distinction," we are told, "between stars, comets, and nebulæ rests on no physical basis." Stars, on the other hand, of the Sirian and solar types (constituting the only true "suns") are vaporized meteor-swarms; their high temperatures represent the surrendered velocities of myriads of jostling particles, drawn together by the victorious power of gravity.

"Collisions" are not however exclusively relied upon for the cosmical production of light and heat. It is admitted that the luminosity of comets and nebulæ must be largely due to electrical excitement; nor is any reason apparent why its influence should be restricted to these two classes of bodies. Destruction of movement by impacts can scarcely be made to supply its place. Occasional illuminative effects may be derived from it, but none that are uniform and permanent.

The small bodies which, more or less plentifully distributed, appear to pervade space, are in this theory treated as the fundamental atoms of the universe. But it is evident that we can not begin there. They have a history, marked perhaps by strange vicissitudes. They may be agents of regeneration, but they are almost certainly products of destruction. Possibly they are seed as well as dust, and serve as the material link between the creation and decay of successive generations of suns.

The orbits of meteorites.—Prof. H. A. Newton, of Yale College, has carefully studied the evidence available for determining the "former orbits of those meteorites that are in our collections and that were seen to fall." Of these stone-falls there are three classes: (*a*) 116 falls for which we have statements as to the direction of the path through the air; (*b*) 94 falls of which we know the time of day; (*c*) 50 or more falls of which the history is too scanty to give the time of day. He is led to the following three propositions:

1. The meteorites which we have in our cabinets, and which were seen to fall, were originally (as a class and with a very small number of exceptions) moving about the sun in orbits that had inclinations less than 90°; that is, their motions were direct, not retrograde.
2. The reason why we have only this class of stones in our collections is not one wholly or even mainly dependent upon the habits of men; nor on the times when men are out of doors; nor on the places where men live; nor on any other principle of selection acting at or after the arrival of the stones at the ground. Either the stones, which are moving in the solar system across the earth's orbit, move in general in direct orbits, or else for some reason the stones which move in retrograde orbits do not in general come through the air in solid form.
3. The perihelion-distances of nearly all the orbits in which these stones moved were not less than 0.5 nor more than 1.0, the earth's radius-vector being unity. (*Observatory* 11: 331.)

At the meeting of the Royal Society, November 15, 1888, Prof. G. H. Darwin read an important paper dealing with the mechanical conditions of a swarm of meteorites from a mathematical stand-point.

SOLAR SYSTEM.

Motion of the solar system in space.—Dr. Ludwig Struve has made a careful comparison of the Pulkowa catalogues for 1855 with Auwer's re-reduction of Bradley (epoch 1755), and, as one of his results, has obtained a value of the motion of our system to which a good deal of interest attaches. As it was necessary to assume some connection between the magnitude of a star and its distance, he adopted the following relative scale, regarding a star of the sixth magnitude as at the distance unity:

Mag.	Dist.	Mag.	Dist.
1	0.13	5	0.70
2	0.23	6	1.00
3	0.36	7	1.49
4	0.51	8	2.25

The result he obtains—4.″36—is then the angular motion of the sun in one hundred years, as seen from the average sixth magnitude star. The actual velocity corresponding to this is about 13 miles per second. The point in the sky towards which the sun is moving is in the constellation Hercules. By combining his results with those of other astronomers, Struve adopts for the mean a displacement of about 5″, corresponding to a velocity of 15 miles per second. The point toward which the system is moving is still in Hercules, right ascension 266°.7, declination +31°.0.

The following table shows how the various determinations of these coordinates agree:

	A.	D.	Epoch.	No. of stars.
	°	°		
W. Herschel	260.6	+26.3	....	....
Do	245.9	+40.4	....	....
Gauss	259.2	+30.8	....	....
Argelander	259.9	+32.5	1792.5	390
Lundahl	252.5	+14.4	1792.5	147
O. Struve	261.5	+37.6	1790	392
Galloway	260.1	+34.4	1790	78
Mädler	261.6	+39.9	1800	2,163
Airy	261.5	+24.7	1800	113
Dunkin	263.7	+25.0	1800	1,167
Gyldén	273.9	....	1800 ?	(?)
Do	260.5	....	1800	(?)
L. de Ball	269.0	+23.2	1860	67
Rancken	284.6	+31.9	1855 ?	106
Bischof	285.2	+48.5	1855	480
Ubaghs	262.4	+26.6	1810 ?	464
L. Struve	273.3	+27.3	1805	2,509
Plummer	270.1	+20.3	....	274
Do	276.1	+26.5	....	274

For the magnitude of the motion in a century we have—

O. Struve	4.″31
Dunkin	5. 22
L. Struve	4. 36
Gyldén	6. 80
Do	5. 89

as seen from a star of the sixth magnitude.

SUN.

Rotation time of the sun.—Mr. Crew, of Johns Hopkins University, has made a new determination of the time of revolution of the sun on its axis by comparing the wave-lengths of certain lines in the spectrum when measured in light coming from two opposite limbs of the sun. By Doppler's principle the wave-length of the line in light from the approaching limb ought to be shorter than in the light from the receding limb. The results obtained give a velocity of the photosphere at the sun's equator of 2.437 miles per second; from this the rotation time is determined to be 25.88 days. Mr. Crew's observations indicate an increase in the angular velocity of the surface with increase in the heliographic latitude. This result is opposed to that obtained by Carrington and Spoerer from observations of sunspots.

Dr. Wilsing has found the rotation period from observations of faculæ to be 25.23, and has detected no variation in velocity depending upon the latitude. The difficulty of identifying faculæ on their reappearance, and of measuring their positions with exactness, makes the result somewhat doubtful.

Diameter of the sun.—Dr. Auwers has made a very exhaustive discussion of the sun's horizontal and vertical diameters from the meridian observations of Greenwich, Washington, Oxford and Neuchâtel with special reference to the alleged variations in the mean annual diameters following the period of the sunspot cycle. He concludes that there is no valid reason for supposing the sun's diameter to vary, and that the apparent changes arise from insufficiently determined personal equations. He also points out that meridian observations are quite unsuited for the determination of any possible ellipticity in the sun's disk, and that there is no reason to conclude from these results that such ellipticity exists. The several mean values of the sun's (assumed circular) diameter are:

Greenwich	32′ 2″.36.	Oxford	32′ 3″.19.
Washington	32′ 2″.51.	Neuchâtel	32′ 3″.27.

The discordances are ascribed to instrumental or uneliminated personal peculiarities.

In a second paper Dr. Auwers discusses the apparent changes of both the horizontal and vertical diameter during the course of a year, deduced from meridian observations, and he concludes that the periodic variations in the monthly value of the diameters result not from physical changes in the sun, but from the effect of temperature on the instruments and from difference in the quality of the telescopic images at opposite seasons of the year.

Another discussion of the horizontal diameter of the sun has been made by Professor di Legge from meridian transits of the sun observed at Campidoglio from 1874 to 1883. The mean horizontal diameter at mean distance deduced from 5796 transits by four observers on 2213 days is 32′ 2″.38.

Solar activity in 1887, 1888.—The decrease in spots, faculæ and prominences which was so marked during 1886, and particularly during the latter part of that year, continued in 1887, and although there was no spotless period as long as that of November, 1886, the mean spotted area for the year was much below that of the year preceding. The days of greatest spotted area were July 6, 7, and 8. The agreement in the general form of the curves for spot numbers and magnetic variation was not so close as in some previous years. The fluctuations in the numbers and dimensions of the prominences were less than for the spots, but they also showed a maximum in July. Faculæ accorded well with the prominences, neither faculæ nor prominences following the spots in the marked depression of November.

During 1888 spots were few, small and in low latitudes, and there were frequent intervals in which no spots at all were seen, longer intervals in fact than any since the minimum of 1879. The most prolific month as to entire spotted area, though not as to number of spots, was November, following immediately a long period of quiescence. There was a rough tendency of spots to certain solar longitudes and in latitude, they continued to be more numerous in the southern than in the northern hemisphere. Faculæ did not vary simultaneously with spots, but their diminution as compared with 1886 and 1887, was slight. They showed a very noticeable development during the secondary maximum of September, while the prominences fell off considerably both in September and November, but attained their greatest development in March and April.

Solar spectrum.—Experiments made by Professor Trowbridge and Mr. C. C. Hutchins at the Jefferson Physical Laboratory in Cambridge, have overthrown the proof brought forward in 1879 by Dr. Henry Draper of the existence of oxygen in the sun. They show that when sufficiently powerful apparatus is used to bring out minute details of the spectrum of oxygen and of the sun, the bright regions of the solar spectrum disappear, and hence also the apparent coincidences between them and the spectrum of oxygen upon which Dr. Draper based his proof. The bright bands obtained by Dr. Draper are in fact occupied by numerous dark lines of variable intensity.

Continuing their experiments however they have been led to conclude that there is unmistakable evidence of the existence of carbon in the sun.

In a valuable paper by Mr. C. C. Hutchins and Mr. E. L. Holden, evidence is brought forward to show the probable existence in the sun of bismuth, silver, and platinum, while tin potassium, and lithium are more doubtful. For cadmium two perfect coincidences were found, while there was no good evidence in favor of the presence of lead cerium, molybdenum, uranium or vanadium.

Prof. S. P. Langley has published in the American Journal of Science an abstract of a memoir on the invisible solar and lunar spectrum, in which he summarizes the result of investigations carried on at the Allegheny Observatory in continuation of his previous researches on the infra-red of the solar spectrum to the extent of about three microns. By means of the improved apparatus described, the extreme infra-red solar spectrum has now been searched from three to over eighteen microns; and it is shown that in this region the ratios between solar and lunar heat are completely changed from what they are in the visible spectrum. While the solar light in the latter is about five hundred thousand times that of moonlight, the solar heat received in the invisible part of the spectrum is probably less than five hundred times the lunar. These studies also promise important results for meteorology, by opening to observation the hitherto unknown region of the spectrum, in which are to be found the nocturnal and diurnal radiations, not only from the moon towards the earth, but from the soil of the earth towards space. (*Nature.*)

Total eclipse of the sun, August 19, 1887.—Unusual preparations were made throughout Europe for observing this eclipse, and great popular interest was manifested in the event, but, unfortunately, very few observations of value were obtained on account of the generally cloudy weather that prevailed over the whole region west of the Ural mountains. The central line of the eclipse first struck the earth at a point 53 miles west-northwest of Leipsic, where the sun was just rising. The line of totality, which was about 135 miles wide, then crossed Germany, Russia, Siberia, China and Japan, and left the earth at a point in the Pacific Ocean in latitude 24° 27′ north, longitude 173° 30′ east.

Eclipse of the moon, January 28, 1888.—The total eclipse of the moon on January 28, 1888, presented an unusually favorable opportunity for observing the occultations of a large number of faint stars, and, in order to secure as many observations of these phenomena as possible, Dr. Döllen, of Pulkowa, prepared and sent out to the principal observatories in Europe and America, a list of the stars to be occulted at each. He reports that he has received three hundred and ninety-six observations of disappearances and three hundred and eighty-seven of re-appearances, the places of observation being so favorably situated, that he considers that there is ample material for determining the position, the diameter, and possibly the ellipticity and parallax of the moon.

SOLAR PARALLAX AND THE TRANSITS OF VENUS.

Professor Harkness, at the meeting of the American Association in Cleveland on August 20, 1888, gave a description of the instruments and reduction processes employed by the United States Transit of Venus Commission in determining the solar parallax from the measurement of photographs taken at the ten American stations in December, 1882; Washington, Cedar Keys, San Antonio, Cerro Roblero, Princeton, and the Lick Observatory, in the United States; Santa Cruz and Santiago, South America; Wellington, South Africa, and Auckland, New Zealand. The preliminary value of the parallax deduced from the measured distances of the centres of the sun and of Venus on 1,475 photographs is $\pi = 8''.847 \pm 0''.012$. The American photographs in 1874 gave $\pi = 8''.883 \pm 0''.034$, and the French $\pi = 8''.80$. The distance of the sun corresponding to the value now obtained—8″.847—is 92,385,000 miles, with a probable error of only 125,000 miles. These numbers are doubtless close approximations to the results which will be obtained from the complete discussion of all the photographs, but they cannot be regarded as final for several reasons, chief among which is the fact that the reduction of the position angles of Venus relatively to the sun's center is still unfinished.

The report of the committee appointed to superintend the arrangements for the expeditions sent out by the British Government to observe the transit of Venus in 1882 has been published. It consists almost entirely of a discussion by Mr. Stone of the observations of contact. Expeditions were sent from England to Jamaica, Barbadoes, Bermuda, Cape of Good Hope, Madagascar, New Zealand, and Brisbane, Queensland, and the observers at all these stations were successful, except at Brisbane, where the weather was cloudy. It will be remembered that the English committee did not feel satisfied with the photographic work in 1874, and for various reasons they determined in the second transit to put their reliance entirely upon contact observations. From the observations of external contact at ingress Mr. Stone obtains a parallax of 8.″760±0″.122; from those of internal contact at ingress, 8″.823±0″.023; from those of internal contact at egress, 8″.855±0″.036, and from external contact at egress 8″.953±0″.048. The most probable combined result he considers to be 8″.832±0″.024, which corresponds to a mean distance of 92,560,000± miles between the earth and sun, with an uncertainty of 250,000 miles.

The fourth volume of the report of the German Transit of Venus Commission was published in 1887, under the editorship of Dr. Auwers. It contains the observations in detail made with the heliometer by various observers, both before and after the transits of 1874 and 1882, for the purpose of determining the instrumental constants.

The report of the Brazilian expeditions has been printed in a quarto volume of 700 pages. Three stations were occupied: St. Thomas, in the Antilles; Olinda, Brazil; and Punta Arenas, in the Straits of Magellan. The transit was observed by projecting the sun's image formed by an equatorial refractor of 6.3 inches aperture upon a screen and noting the times of contact. The result given for the value of the parallax from the internal contacts is 8″.808.

Professor Hall, using a value of the constant of aberration 20″.4542, deduced from a series of observations of α Lyrae, made at the U. S. Naval Observatory during the years 1862 to 1867, and introducing Michelson and Newcomb's determination of the velocity of light, has found for the solar parallax 8″.810 ± 0″.0062.

PLANETS.

MARS.—The observations of Perrotin, Terby, and Denning have confirmed the presence of most of the so-called "canals," or narrow, dark lines, that were discovered by Schiaparelli in 1877, and at subsequent oppositions, and in some cases the gemination or doubling of the canals has been detected.

Considerable interest has been aroused in regard to Mars on account of the recent changes reported in the markings upon its surface by Perrotin and others. The chief change reported was the apparent inundation or disappearance of the "triangular continent," to which the name of Libya has been assigned, but the report has not been confirmed by the observations of Schiaparelli, Terby, Niesten, and Holden. The observations of Professor Holden and his assistants with the 36 inch refractor began on July 16, 1888, and were continued to August 10; the planet was therefore very unfavorably situated, its diameter being less than 9″. Several of the most important canals were seen, but they were not double, appearing rather "as broad bands covering the spaces on M. Schiaparelli's map which are occupied by pairs of canals and by the spaces separating the members of each pair." Professor Hall, with the Washington 26-inch refractor, has never been able to see these markings so sharply drawn by European observers. The only remarkable change he noticed was the diminution in the size of the white spot at the south pole of the planet.

Numerous sketches of Mars showing the canals or other markings have been published by Holden, Perrotin, Terby, and Niesten. No adequate explanation of the canals, or of the changes observed, has yet been offered.

JUPITER'S SATELLITES.—Astronomers have always been puzzled by the discordant appearances of the satellites during transit, but more especially by the fact that the phenomena do not apply equally to all the satellites, or even in some instances to the same satellite in two successive revolutions. The fourth, for instance, as it approaches the disk of Jupiter becomes rapidly fainter till it arrives at contact. When once on the limb it shines with a moderate brilliancy for about ten or fifteen minutes, then becomes suddenly lost to view for a similar period, and lastly reappears, but as a dark spot, which grows darker and darker until it equals the blackness of its own shadow on the planet. The appearance of the second satellite, however, is entirely different, for it seems never to have been seen otherwise than pure white during transit; whereas the first and third differ yet again from the preceding two. The former is sometimes a steel-gray, and at others a little darker, whereas the latter has been seen perfectly white and yet so black as to be mistaken for the fourth. Mr. E. J. Spitta has made a careful investigation of these interesting phenomena, communicating his results in a paper of some length, read at the meeting of the Royal Astronomical Society, in November, 1887. His experiments consisted essentially of numerous observations upon suitably prepared models representing the planet and satellites, and he concludes (see Nature 37:468, March 15, 1888) that the probable reason the fourth satellite is uniformly black during transit, when it has passed its period of disappearance, is, that its albedo is so low as to grant the difference between it and the background necessary for a body to appear black when superimposed on another. Its preliminary whiteness and disappearance are also shown to be a question of relative albedo, for they are due to the fact that a sphere at its limb loses so much in reflective power that up to that moment the satellite possesses sufficient albedo (as compared with the background in that situation) to maintain its whiteness. So, too, with the second satellite. Its albedo proves to be so high that it is capable of preserving its brilliancy throughout the entire transit.

The third and first satellites evidently possess sides of different albedo, one high enough to maintain a brighter aspect than the other, or even, as in the case of the third, to make it appear white when one side is presented to the earth and dark when the other. Finally, to quote from the original paper, "it is not unreasonable to conclude that these anomalous phenomena are due to functional idiosyncrasies in the eye itself, rather than to physical peculiarities of the Jovian system."

Mr. Denning has obtained from observations of the red spot made between February 12 and August 22, 1888, a rotation of $9^h\ 55^m\ 40^s.24$, nearly one second less than the spot gave in 1885–'86, though six seconds greater than in 1879.

The value obtained for the mass of Jupiter by von Haerdtl in his discussion of Winnecke's comet is 1: 1047.152 ± 0.0136.

SATURN.—The first number of a new series of publications called Supplements to the Pulkowa Observations contains an interesting memoir by Dr. Hermann Struve on the outer satellites of Saturn. He discusses his own observations made with the 15-inch refractor in the years 1884–1886 on Iapetus, Titan, Rhea, and Dione, with a view to correcting the elements of these satellites, and also the values of the mass and ellipticity of Saturn. The mass of Saturn was found by Bessel to be 1 : 3501.6 ± 0.77, or with a slight correction indicated in the present paper, 1 : 3502.5. Prof. Asaph Hall, on the other hand, obtained the value 1 : 3481.3 ± 0.54. Struve considers the rather large discordance between these values due to systematic error in measuring the distance of a satellite from a limb, and his own observations consist entirely of comparisons of one satellite with another, either by differences of right ascension and north polar distance or of distance and position angle. His resulting value of the mass of Saturn agrees closely with Bessel's, being 1: 3498. The correction of the elements has been carefully and laboriously carried out by the method of least squares. (*The Observatory*, 11 : 303, July, 1888.)

Mr. G. W. Hill, in his paper on the motion of Hyperion and the mass of Titan, has obtained for the latter 1 : 4714, Saturn's mass being unity. Newcomb's corrected value, and Ormond Stone's value, accord well with this.

URANUS.—Dr. Valentiner, of the Karlsruhe Observatory, and his assistant, Dr. von Rebeur-Paschwitz, were able to detect in April, 1887, a slight ellipticity in the disk of the planet Uranus, but their instrument, a 6-inch equatorial, was not of sufficient power to make satisfactory measures.

NEPTUNE.—Tisserand has shown that the progressive changes in the node and inclination of the orbit of the satellite of Neptune can be explained by supposing a slight flattening of the surface of the planet; but the flattening would probably be too slight to be measured. Further observations may enable the amount of the inclination to be more exactly determined, and at the same time will show whether the changes in question are due to this cause alone.

THE MINOR PLANETS.—Seventeen of these small bodies were added to the group during the years 1887 and 1888, making the total number now known 281.

The new discoveries, with approximate elements, are given in the following table. All except number 270 were below the eleventh magnitude, and some slight confusion at first occurred in the numbering, owing to the difficulty of distinguishing a new asteroid from one already known in the absence of a very carefully computed ephemeris. For instance, numbers 268 and 279 were at first thought to be identical with 149, Medusa; 277 with 228, Agathe; 280 with 255, Oppavia; while an asteroid detected by Luther on April 11, 1887, and independently by Coggia on April 16, proved to be 69, Hesperia, which had been looked for in vain in 1882 and 1885; and one found by Borelly on May 12, 1888, to which the number 278 was assigned, though it was suspected to be identical with 156, Xanthippe, eventually proved to be 116, Sirona.

List of minor planets discovered in 1887 and 1888.

Number and name.	Discoverer.	Date of discovery.	Longitude of perihelion.	Longitude of node.	Inclination.	Eccentricity.	Mean daily motion.	Mean distance from sun.	Period in years.
		1887.	°	°	°		″		
265 Anna	Palisa, at Vienna....	Feb. 25	226.0	335.4	25.8	0.26	942	2.42	3.77
266 Aline.......	....do	May 17	23.8	236.3	13.3	.16	754	2.81	4.70
267 Tirza.......	Charlois, at Nice....	May 27	264.3	74.0	6.0	.10	768	2.77	4.62
268 Adorea	Borrelly, at Marseilles.	June 9	184.8	121.8	7.3	.13	655	3.08	5.42
269 Justitia.....	Palisa, at Vienna	Sept. 21	274.6	157.3	5.4	.20	838	2.62	4.23
270 Anahita	Peters, at Clinton.	Oct. 8	333.1	254.5	2.4	.15	1000	2.20	3.26
271 Penthesilea.	Knorre, at Berlin ...	Oct. 13	24.8	337.5	3.6	.10	681	3.01	5.21
		1888.							
272 Antonia ...	Charlois, at Nice....	Feb. 4	21.4	37.0	4.6	.03	770	2.77	4.61
273 Atropos	Palisa, at Vienna ..	Mar. 8	285.0	158.8	20.8	.14	974	2.37	3.64
274 Philagoria..	....do	Apr. 3	212.8	93.6	3.7	.12	668	3.04	5.31
275 Sapientia ...	....do	Apr. 15	162.9	134.9	4.8	.17	769	2.77	4.61
276 Adelheid ...	....do	Apr. 17	120.6	211.6	21.7	.06	644	3.12	5.51
277 Elvira	Charlois, at Nice....	May 3	....	233.5	1.1	.09	......	2.87	.....
278 Paulina ...	Palisa, at Vienna...	May 16	224.8	62.4	7.5	.11	786	2.73	4.52
279 Thule	....do	Oct. 25	298.8	75.2	2.4	.11	405	4.25	8.75
280 Philia	....do	Oct. 29	96.9	10.9	7.4	.14	692	2.97	5.12
281 Lucretia....	... do	Oct. 31	45.9	31.0	5.3	.13	1096	2.19	3.24

Number 265 is remarkable on account of the very considerable inclination of the plane of its orbit to that of the ecliptic, and also on account of its near approach to the earth, its least distance from us being 0.96, in terms of the earth's mean distance from the sun; it would therefore seem to offer an additional means of determining the value of the solar parallax. Number 270 also approaches quite near the earth, $\triangle = 0.81$. It will be noticed that 279, with its mean distance from the sun of 4.25, considerably greater than that of any other asteroid, lies upon the extreme outer limit of the group, and will at certain times, therefore, be brought quite close to Jupiter, and by the perturbations thus experienced may furnish further knowledge of the mass of that planet. Number 281, with its small mean distance of 2.19 lies, on the other hand, near the inner border of the group; it is the sixty-eighth asteroid discovered by Dr. J. Palisa.

Prof. Tietjen discontinues with the year 1888, the regular issue of the Circulars and Correspondence of the Berlin Jahrbuch, relating to asteroids. Special attention will be given hereafter to the orbits of newly discovered planets presenting interesting peculiarities.

The Annals of the Harvard Observatory, volume 18, No. 3, contains a discussion of a series of photometric observations of the asteroids by Mr. H. M. Parkhurst, extending from April to December, 1887. The method of observation was to note the time that the asteroid took to disappear after passing a transit wire, the telescope being stationary, and the light of the asteroid or comparison star suffering diminution either by a wedge or more frequently by a deflector—a piece of glass with nearly parallel sides placed in the telescope tube, about one seventh of the way from the focus to the object glass, and covering half the field. The conclusions reached by the author are as follows:

(1) The phase correction can not be neglected, and is peculiar to each asteroid.

(2) There may be, for certain asteroids, large errors from rotation.

(3) In most cases, after the phase correction has been determined, the remaining unknown errors are less than the average variation of the fixed stars.

REPORTS OF OBSERVATORIES.

In collecting the following notes upon observatories the latest available information has been utilized, but it has been found impossible to bring the report in each case down to the end of 1888. The Vierteljahrsschrift, for instance, from which the data for many European observatories are drawn, contains reports no later than 1887, and comparatively few observatories publish independent annual reports. The writer's thanks are due to Sr. Felipe Valle for notes on the observatories of Mexico.

Ann Arbor.—Prof. W. W. Campbell has been appointed assistant to fill the vacancy made by the removal of Mr. Schaeberle to the Lick Observatory.

Armagh.—Dr. Dreyer has devoted a large part of his time to the preparation and passing through the press of a new general catalogue of nebulæ.

Bamberg.—An interesting description of the new observatory is given in the Vierteljahrsschrift for 1887, p. 333, by the director, Dr. E. Hartwig. The sum of $45,000 was available for buildings, $17,500 for instruments, the interest on $20,000 for salaries, and on $12,500 for maintenance, with a reserve fund of about $20,000. The observatory consists of two buildings, the observing-rooms being in one and the offices and dwelling in the other. In the first there are two towers surmounted by domes and connecting them is the transit room. A long covered way from the dwelling gives easy access to the instruments. The latter are a 7-inch Repsold-Merz heliometer similar to the one at the Cape, a 10 inch refractor, a Repsold-Merz transit with zenith-telescope attachment, 6-inch Merz comet-seeker, clocks, chronometers, and subsidiary apparatus.

Basel (1886).—The astronomical observatory and meteorological station are under the direction of Dr. E. Hagenbach-Bischoff, assisted by Dr. Riggenbach. The instruments are used principally for the determination of time and for the instruction of students.

Beloit.—The equipment of the Smith Observatory, Beloit College, which was built in 1883 and ready for work in 1884, consists of an equatorial refractor of 9½ inches aperture, objective by Clark, mounting by Warner and Swasey; a combined transit and zenith telescope of 2.6 inches aperture, made by Prof. C. S. Lyman (*see* Amer. Jour. Sc., XXX, p. 52); clocks, sidereal chronometer, chronograph and minor apparatus, and meteorological and photographic outfit. Directors: John Tatlock, jr., 1884-'85; C. A. Bacon, 1885. A local time service is maintained, and meteorological observations are published daily.

Berkeley, California.—The "Students'" observatory of the University of California, established in 1887, is designed to furnish to under graduates instruction in geodesy and the more practical parts of astronomy generally; as rating clocks and chronometers, determining geographical latitudes and longitudes, etc. It is also designed to encourage study, on the part of the more advanced under-graduates, of astronomical phenomena, as far as they may be within the reach of young amateurs.

A neat and sufficiently commodious observatory building, 50 feet long by 20 feet wide, on the average, has been built on a knoll in the university grounds 320 feet above mean sea-level. In the dome-room, at the east end of the observatory, is an equatorial refractor of 6½ inches clear aperture, objective (achromatic), by J. Byrn, of New York, the mounting, driving-clock, pier, etc., being by Fauth & Co., of Washington. With this telescope are six negative and as many more positive eye-pieces, and a fine position filar micrometer made by the same firm. A spectroscope, capable of attachment to the equatorial or of being used on a stand, is furnished with a flint prism, and also with one of Rowland's diffraction gratings, having 14,334 lines to the inch.

In the room next west are two of J. Green's standard barometers, and in a specially prepared shed upon the north side, a wet bulb, a dry bulb, a maximum, and also a minimum thermometer, by H. J. Green, of New York. In this shed is also placed one of Draper's self-registering "thermographs."

On the northwest tower of the College of Letters are mounted a Robinson anemometer and a wind-vane. These instruments are connected by telegraph wires with an anemograph in the observatory, where the velocity and direction of the wind are automatically recorded. Meteorological observations and records are made at 7 A. M., 2 P. M., and 9 P. M. (standard or mean time of the 120th meridian of longitude). Monthly printed reports are made to the U. S. Signal Service office in San Francisco.

In the next room west is mounted a fine, large, portable "transit and zenith telescope," of the type used by the U. S. Coast and Geodetic Survey, but having an objective 3 inches in diameter.

Two diagonal and two direct eye-pieces belong to this instrument. In the same room is a Howard Standard mean time clock, with gravity escapement, mercurial compensating pendulum, and electric circuit connections. The clock is fastened to a solid granite pier 18 inches square and 6 feet long, which is inclosed in a brick pier reaching to solid rock 5 feet below the surface of the ground. The transit and equatorial are similarly founded. All the piers are disconnected from the floors of the observatory. A sidereal chronometer, made by Negus Bros., New York, is mounted upon one side of the transit pier.

On a shelf at one side of the transit-room is an electro-chronograph, by Fauth & Co., of Washington, and on another the switch-board made by the San Francisco Electric Company. An electric circuit runs through the clock, chronometer, chronograph, sounder, and relay, and also into the equatorial-room, from which time may be marked on the chronograph by means of a break-circuit key. The switch-board is connected with the Western Union telegraph line by a shortline to Dwight Way-Station, Berkeley.

The two rooms further west are used respectively as a repair shop and a sleeping-room for the assistant.

In a small house at the rear of the observatory, upon a brick pier specially made for the purpose, are mounted three seismographs, the Duplex, the Ewing rotating, and the Gray.

The latitude of the mercury basin in the center of the transit pier of the observatory has been found from the first series of observations (preliminary to a continued series) to be $+ 37° 52' 21''.7$. Longitude west of Greenwich $8^h 9^m 2^s.52$.

The observatory is in charge of Prof. Frank Soulé, professor of civil engineering and astronomy, University of California.

Berlin.—The principal work of the meridian circle has been upon the Pulkowa list of stars and Argelander's stars, with considerable proper motion; a few comparison stars were observed, and preliminary experiments made to determine the influence of brightness of stars upon the observed time of transit. The 9-inch equatorial has been employed upon comets, asteroids, and comparison stars, and the declinograph attached to this instrument in observing zones in the thicker parts of the milky-way. With the smaller meridian instrument a series of observations of comparison stars has been begun, and with the heliometer measures of double stars and the Pleiades. In the annual reports of this observatory, given by Professor Foerster in the Vierteljahrsschrift, will be found interesting notes upon the performance of the clocks and time service.

The Recheninstitut, under Professor Tietjen, has published, as usual, the Jahrbuch, and circulars relating to the minor planets.

Bonn.—Dr. Schoenfeld reports satisfactory progress of the observations and reductions of zone $+40°$ to $+50°$. The remaining charts of the Southern Durchmusterung have been completed and distributed, and an investigation of errors in star catalogues covered by these charts is approaching completion. A few observations of variables have been made. Dr. Mönnichmeyer succeeded Dr. Scheiner as assistant on January 1, 1887, the latter having accepted a position at Potsdam.

Bordeaux.—The second volume of Annales, published in 1887, contains a memoir by Flamme upon elliptic motion of the planets, a determination of the latitude by Rayet, and a series of observations made with the meridian circle for a revision of Oeltzen's catalogue of Argelander's southern stars; also magnetic and meteorological observations.

Breslau.—Observations mainly meteorological and magnetic, and for the time service.

Brighton (*Massachusetts*).—Mr. E. F. Sawyer, of Cambridgeport, has removed to Brighton, upon the outskirts of Boston, and continues his observations of variables.

Brooklyn (*New York*).—Mr. H. M. Parkhurst's private observatory was originally built in 1862 and provided with a 6-inch telescope. It was rebuilt in 1877 and a 9-inch refractor was mounted. A series of photometric observations made by Mr. Parkhust has been published in the Harvard Observatory Annals, vol. 18, No. 3. Approximate position, latitude, +40° 41′ 2″; longitude, 4^h 55^m $50^s.1$ west of Greenwich.

Brussels.—A catalogue of 10,792 stars upon which work was begun more than thirty years ago by Quetelet has at length been finished. M. Stuyvaert is engaged upon the formation of a catalogue of comparison-stars, which have appeared in volumes 107 and 108 of the Astronomische Nachrichten. Double stars, comets, and occultations by the moon have been observed with the equatorials of 38 and 15 centimeters, and numerous physical observations of the moon and planets have also been made. M. l'abbé Spée is especially occupied with a study of solar spots and protuberances, and M. Fievez with the study of the solar spectrum. The new observatory at Uccle is practically finished.

Cambridge (*England*).—Considerable progress has been made with the zone +25° to +30°.

Camden (*New Jersey*).—Mr. E. E. Reed has erected a small private observatory, with 6 inch equatorial.

Cape of Good Hope—With the transit-circle regular observations have been continued of the Sun, Mercury, Venus, stars on the list of the Cape ten-year catalogue for 1890, comet comparison stars, stars occulted by the Moon, stars employed in the latitude and longitude determinations of the Geodetic Survey, and stars employed in zones for determining the scale value of the heliometer. The large theodolite has been used for observations of circumpolars and latitude stars, the zenith telescope for latitude, and the equatorial for observations of comets. The photographic "Durchmusterung" is proceeding rapidly, the instrument being kept at work by two observers from evening twilight till dawn. The reduction of the plates from declination —90° to —77½° has been completed by Professor Kapteyn, and plates for measurement to —57° have been sent to him. It is expected that the photographs will be completed by the end of 1889; their reduction will probably require two years longer. The new heliometer was received from Repsold, and mounted in the latter part of 1887; it is pronounced by Dr. Gill the most powerful and convenient instrument for refined micrometric research at present in existence. A complete working programme has been prepared, including the determination of the parallax of all the southern stars brighter than magnitude 2.0 and all the stars most remarkable for proper motion. Some progress has been made in the determination of the constants of the instrument. The meridian observations for 1882, 1883, and 1884, occultations observed from 1835 to 1880, forming vol. 1, part 4 of the Annals, and a discussion of the variations of the instrumental adjustments of the transit circle have been published.

Carleton College.—An illustrated description of the building and instruments is given in the Sidereal Messenger for October, 1888. The length of the building east and west is 80 feet, north and south 100 feet. The clock-room is on the first floor of the main building, and is 27 feet in diameter. The large circular pier for the 16-inch equatorial (to be constructed by Brashear) is in the middle of this room, suitably cased to a height of 7½ feet, and provided with shelving. The mean-time and sidereal clocks, both by Howard, are mounted in recesses in the east and west faces of this pier. In the west wing, upon the same floor, is the library with about 1,400 bound volumes, a small study or class-room, and a janitor's room; to the north is the prime vertical of 3-inch aperture (Fauth), and beyond this a class and lecture room. A small dome over the north wing covers the 8¼ inch Clark refractor. In the east wing is mounted a fine Repsold meridian circle of 4.8 inches aperture, which is under the charge of Dr. H. C. Wilson. The chronograph, chronometer, and time-distributing apparatus are in the clock-room. A time-service over more than 12,000 miles of railway is under the immediate care of Miss C. R. Willard.

The co-ordinates of the observatory provisionally adopted are (Astron. Nachr. 120:85): latitude +44° 27′ 41″; longitude 6^h 12^m $36^s.0$ west of Greenwich.

Cincinnati.—A zone catalogue of 4,050 stars observed with the 3-inch transit was published in 1887. In September, 1888, a new meridian circle, by Fauth & Co., was mounted, one of the first large instruments of this class made in the United States. The clear aperture of the object-glass is 5¼ inches, and the focal length 70 inches; object-glass and micrometer are inter-changeable. The piers are of masonry to the floor-level, and from there up an iron frame work bricked inside to within a foot of the top. The pivots are of steel, glass hard. There are two solid circles, 24 inches in diameter; one is divided very coarsely to half degrees only: the other has two sets of graduation upon a silver band, both of them to 5′. The inner one is somewhat heavier than the other, and does not pretend to great accuracy, being used merely for setting. The outer graduation alone is visible in the reading miscroscopes; as far as Professor Porter has carried his investigation the errors of this graduation are very small. Electric illumination has been used throughout and has been found practically perfect. A detailed description of the instrument will be found in the Sidereal Messenger for January, 1889.

Cointe (*Liège*).—Observations of Titan and Iapetus have furnished a determination of the mass of Saturn. The meridian circle has been used for zone observations.

Copenhagen.—Mr. Nielsen has recently erected a private observatory with a 6½ inch refractor by Reinfelder & Hertel, intended principally for selenographical work.

Cordoba.—Volumes 6 and 9, containing the zone observations made in 1875 and 1876, have been published.

Dearborn.—The report for 1885 and 1886, which has not previously been noticed, contains a list of nebulæ discovered by Professor Safford in 1866–'68; papers on the motion of the lunar apsides and on the companion of Sirius by Professor Colbert; and an illustrated paper on the physical aspect of Jupiter, a catalogue of 209 new double stars, and a description of a printing chronograph by Professor Hough. In the course of the two years referred to 130 new double stars were discovered and measured.

In consequence of the dissolution of the University of Chicago the Chicago Astronomical Society dismounted their instruments in the early part of 1888, and transferred the care of the observatory to the Northwestern University, at Evanston, Illinois, 12 miles from the business center of Chicago, about 16 miles north and 3 miles west of the old site, and some 300 feet from the shore of Lake Michigan. The corner stone of a new building, the gift of James B. Hobbs, was laid June 24, 1888. The plan includes a tower and dome for the 18½-inch equatorial, meridian circle room, library, and about eight rooms for other purposes; the whole to be erected at a cost of $25,000. The approximate position is given: Latitude, +42° 3′; longitude, $5^h\ 50^m\ 42^s$ west of Greenwich.

Denver.—A new observatory, the gift of Mr. H. B. Chamberlin to the University of Denver, is being built, about 7 miles from the city of Denver, at an altitude of 5,000 feet above sea-level. The principal instrument is to be a 20-inch Clark refractor. Director, Prof. H. A. Howe.

Dresden.—Baron von Engelhardt's older observatory was built in 1877 (latitude, +51° 2′ 31″; longitude, $0^h\ 54^m\ 53^s.3$ east of Greenwich), and contained an 8-inch Grubb equatorial, a 2-inch Cooke transit, and a sidereal clock by Knoblich. The present observatory was built in 1879 somewhat nearer the outskirts of Dresden (latitude, +51° 2′ 19″; longitude, $0^h\ 54^m\ 54^s.7$ east of Greenwich). It consists of a three-story tower, the upper story being surmounted by a cylindrical "dome" covering a 12-inch Grubb equatorial. The second floor connects with the transit-room, in which is a "broken-back" transit, by Bamberg, of 2.7 inches aperture. There is also a very complete equipment of subsidiary apparatus, clocks, chronometers, chronograph, etc. Upon the adjoining roof of the baron's residence is a little comet observatory arranged for two instruments, one of 6.4 inches aperture and the other of 3.7 inches. The larger instrument, which is similar to the Strassburg comet-seeker, is of somewhat novel construction. The telescope is fastened by two long arms to the back of a chair so that the eye-end comes at a convenient position for the observer; the arms are pivoted to the chair-back, permitting a motion in altitude, while the chair may be rotated in azimuth, so that the astronomer can examine the whole sky rapidly and without fatigue.

The numerous and valuable observations of occultations, phenomena of Jupiter's satellites, comets, planets, new stars, nebulæ, and clusters were collected and published in the latter part of 1886, together with an illustrated description of the observatory and instruments. Similar observations have been continued during the past two years, and considerable progress has also been made with a series of micrometric measures of all stars in Bradley and Argelander, which have an annual proper motion of at least 0″.1, with companions not below the tenth magnitude, and distance not greater than 3′.

Dresden (K. math. Salon).—Meteorological observations and a local time-service.

Dunecht.—Spectroscopic work has consisted of measures upon stars and nebulæ and a study of the low-sun atmospheric lines, as seen from an observing station established upon a neighboring hill. Circulars of astronomical information, the weekly firing of the time-gun, and the daily meteorological observations have been continued as in former years. A catalogue of the library is in press.

Dunsink.—The meridian circle has been devoted to observations of a list of about 1,000 stars suspected of large proper motion. Part VI of "Observations" was issued in 1888, containing the observations from 1881 to 1885 made with the meridian circle on 1,012 stars of the southern Durchmusterung requiring re-observation.

Düsseldorf.—Observations of comets and asteroids and ephemerides of the latter.

Ealing.—Mr. Common has completed his 5-foot reflector.

Edinburgh.—Prof. C. Piazzi Smyth resigned in August, 1888, the appointments (which he has held since 1846) of regius professor of practical astronomy in the University of Edinburgh and astronomer royal for Ireland, and he has given a very discouraging account of the financial condition of the institution. Dr. Ralph Copeland, of the Dun Echt Observatory, has been appointed as his successor.

Geneva.—In addition to the regular work of rating chronometers and watches, observations have been made of comets, of nebulæ, and of the rings of Saturn. A series of observations made by Plantamour and von Oppolzer, in 1881, for the purpose of determining the difference of longitude between Geneva and Vienna, have been discussed, giving a mean value of the difference of longitude of $40^m\ 44^s.64$ (Geneva west of Vienna).

Geneva (New York).—Mr. William Smith built in 1888 a small private observatory, which he has placed in charge of Mr. W. R. Brooks, well known for his discoveries of comets. The instrumental equipment is as follows: equatorial refractor, objective, by Clacey, of 10½ inches aperture and 9 feet 9 inches focal length, with a photographic corrector of the same aperture. The mounting is by Warner & Swasey, and embodies numerous convenient devices. There is a large Gundlach periscopic comet eye-piece of 3 inches equivalent focus, with a silvered flat diagonal of 3½ inches, a position micrometer, polarizing eye piece, universal Brashear spectroscope fitted with grating and prisms, and suited for stellar, solar, or laboratory work. The meridian circle is by Warner

& Swasey, 4-inch aperture and 40-inch focus, with 16-inch circles: one circle is coarsely divided, the other is divided to 5′ and is read by two microscopes to 1″. The sidereal clock was made by the Self-winding Clock Company, of Brooklyn, New York; it has Gerry's patent gravity escapement, and is automatically wound by a small electric motor. The chronograph was designed and constructed by the director. Outside the observatory proper, but ready for occasional use, are the 9-inch, 5-inch, and 3-inch reflectors, also built by Mr. Brooks, and used by him at Phelps, New York, in searching for comets.

Georgetown (*District of Columbia*).—The observatory of Georgetown College (built in 1845) was placed under the charge of Father J. G. Hagen, S. J., in the winter of 1888. The buildings and instruments, which have been but little used for nearly forty years, have been thoroughly renovated at considerable expense. Father Hagen has not as yet laid out any plan for the future work of the institution.

Glasgow (*Scotland*).—Observations with the transit circle of a list of stars in the earlier volume of Weisse's Bessel.

Glasgow (*United States*).—See Morrison Observatory.

Gohlis.—The private observatory of Herr Winkler was transferred in 1887 from Gohlis, near Leipzig, to the neighborhood of Jena—latitude, +50° 55′ 35″.6; longitude, $0^h\ 46^m\ 20^s.8$ east of Greenwich.

Gotha.—Considerable progress has been made in the reduction of the zone observations (25°—20°). With the meridian circle observations of moon culminations and of stars of Mayer's catalogue have been made, and with the equatorial, observations of comets, of asteroids, and of Gore's variable near χ^1 Orionis.

Dr. Becker has, at the request of Professor Newcomb, collected in a convenient form Hansen's formulæ for the general perturbations by Jupiter and has applied them to the planet Eurynome. It will be remembered that Prof. J. C. Watson made provision in his will for the computation of tables of the asteroids discovered by him, which will readily give the places of the planets at future oppositions. Dr. Becker's work is for the purpose of facilitating these computations.

Dr. Paul Harzer succeeded Dr. Becker as director on December 1, 1887.

Göttingen (1886).—Dr. Schur assumed charge of the observatory on April 1, 1886, and immediately set to work to have much needed and very extensive repairs made in the buildings and instruments. As most of the instruments have been dismounted, the principal work done has been upon a new reduction of the zone observations made by Klinkerfues from 1858 to 1863. A 6-inch Repsold heliometer has been ordered. The personnel of the observatory consists (with the director) of observator, Dr. Battermann; assistant, Herr Clemens, and computer, Heidorn.

Greenwich.—The regular meridian observations of the sun, moon, and major and minor planets have been kept up as before, and satisfactory progress has been made with the reductions for a new ten-year catalogue (1877–'86). Observations of the moon have been made with the altazimuth, and of comets with the equatorial. The spectroscopic observations for determining the motions of stars in the line of sight, the photoheliographic record of the sun's surface, the magnetic and meteorological observations, the chronometer and time service are also continued as heretofore. A crown disk for the 28-inch objective, has, after several failures, been obtained by Grubb from Chance & Co., and the Treasury has granted the necessary funds for a 13-inch photographic telescope to enable the observatory to take its share in the scheme for forming a photographic map of the heavens. Numerous experiments have been made in stellar photography in preparation for this work. An 18-foot dome for a photographic equatorial was built in 1888, and at the same time an addition was made to the space available for computing rooms. The annual volume for 1886 has been printed and distributed. We learn that provision has been made for a redetermination of the difference of longitude between Greenwich and Paris. The astronomer royal in his last report draws attention to the recently averted danger from a proposed railway tunnel within 840 yards of the observatory. He also points out the inadequacy of the present staff to handle properly the ever increasing amount of work demanded from a national observatory, as new fields of research are opened up for investigation.

Grignon.—Sketches of the planets, observations of meteors, meteorological observations, and microscopical studies of cosmical dust. Director, Fr. Mayeul Lamey.

Grinnell.—Iowa College has a small observatory, for instruction, with an 8-inch Clark refractor, mounted in April, 1888.

Guadalajara (*Mexico*).—Private observatory of Ingeneiro Carlos F. de Landero; latitude, + 20° 40′ 31″.9; longitude, 6^h 53^m $23^s.66$ west of Greenwich.

Haiphong (*Tonkin*).—The longitude of the small observatory as telegraphically determined by connection with Hong Kong April 5, 6, 7, 1887, is 7^h 6^m $44^s.04$ east of Greenwich.

Harrow.—The work of determining the places of comparision stars and other selected small stars has been continued with the meridian circle. Observations of comets have been made with the equatorial.

Harvard.—Professor Pickering describes the progress of his work under three principal heads: The older instruments of the observatory, the Draper memorial, and the Boyden fund. The 15-inch equatorial has been used upon comets, eclipses of Jupiter satellites, and photometric observations of asteroids. The meridian circle zone catalogue is passing through the press, and some progress has been made in observing the new zone, —9° 50′ to —14° 10′. The work upon which the meridian photometer has been employed since 1882 was finished September 29, 1888. The most laborious part of this work was the determination of the brightness of stars of the ninth magnitude in zones 20 minutes in width at intervals of 5 degrees from the north pole to the declination

—20°. This instrument has been dismounted and sent to Peru, where the work will be continued to the south pole, and in order to extend the investigation from stars of the ninth to stars of the fourteenth magnitude, an instrument of somewhat similar form but with an objective of 12 inches aperture (described under Instruments) has been mounted at Cambridge.

The first extensive research undertaken with the Henry Draper memorial funds, a catalogue of the spectra of 10,875 stars, covering the entire sky north of —25°, is nearly completed. This work has been done with the 8-inch Bache telescope. A second series of photographs made with longer exposures, and so taking in fainter stars, will soon be finished, and this instrument will likewise be sent to Peru, where the observations will be extended to the south pole. The detailed study of the brighter stars with the 11-inch Draper telescope has been continued, and the 15-inch and 28-inch reflectors constructed by Dr. Draper have been mounted and are employed in studying the spectra of variables.

The Boyden fund has been devoted to collecting necessary information in regard to the meteorological conditions at high altitudes, and in furtherance of this object several stations in Colorado were occupied during the summer of 1887 by a party from the observatory provided with special photographic apparatus. In December, 1888, a fully equipped expedition went out to California to observe the total solar eclipse on January 1, 1889, and having successfully completed that task, they proceeded to the southern hemisphere to occupy for several years an elevated station in Peru, and to carry out the photographic and photometric work mentioned above.

The compilation of observations of variable stars, the telegraphic announcement of astronomical discoveries, and the time service have been continued as in previous years. Volume 18 of the Annals is issued in parts in order to provide prompt publication for special investigations. These, as well as the Draper-memorial Reports, have received notice elsewhere. The Bulletin of the New England Meteorological Society and a good deal of other meteorological work will also appear in the Annals. The observatory buildings have been increased by the addition of two neighboring houses, and also by the erection of small detached and inexpensive buildings to cover the different telescopes that have been added to the equipment.

Haverford.—Founded in 1852, enlarged in 1883. Instruments: 10-inch refractor, by Clark; 8¼-inch refractor, re-ground, by Clark; 8¼-inch silver-on-glass reflector; 1¾-inch zenith telescope. Directors: Joseph G. Harlan, 1853; Samuel J. Gummere, ——; Samuel Alsop, jr., 1875; Isaac Sharpless, 1882; Francis P. Leavenworth, 1887. Professor Leavenworth has published a number of observations of comets.

Helsingfors.—The 7-inch refractor has been used for observations of comets, both determinations of position and careful examination of physical characteristics. The transit instrument has been re-modelled by the Repsolds and provided with a circle 48 centimeters in diameter, divided to $2'$ and read by four microscopes.

Halifax.—Observations of the phenomena of Jupiter's and Saturn's satellites, occultations, and transits of stars for time.

Herény.—The chief work has been on celestial photography. Photographs of numerous star-clusters, of the moon, planets, comets, and of stellar spectra have been obtained.

Hurstside, West Molesey, England.—Sir Henry Thompson has built a private observatory with a 12-inch Cooke equatorial, to which is fitted a photographic objective and large prismatic objective for photographing stellar spectra.

Kalocsa.—A careful series of observations of solar phenomena is carried on by the director, Father Julius Fényi.

Kew.—Magnetic, meteorological, and solar observations, verification of instruments, and the rating of watches and chronometers have been continued.

Kiel.—The zone catalogue, $+55^\circ$ to $+65^\circ$, containing 14,680 stars, was finished and prepared for press in 1887. The Kiel observatory is the central station for the telegraphic distribution of astronomical information upon the continent, and in connection with this service considerable work has been done upon the new comets and asteroids by members of its staff.

Königsberg.—Observations of the sun and major planets, of time stars and comparison stars, have been made with the Repsold circle; observations of double stars, comets, and measures for stellar parallax with the heliometer. The director, Dr. E. Luther, died October 17, 1887, and was succeeded April 1, 1888, by Dr. C. F. W. Peters.

Kremsmünster.—The meridian circle has been repaired and remounted in a new building $4''.023$ north and $0^s.225$ west of its old position. Comet observations have been made with the refractor.

La Plata.—Observations of comets by M. Beuf and his assistants have been published. The position of the observatory is given as, latitude, $-34^\circ\,54'\,30''.3$; longitude, $4^h\,0^m\,58^s.0$ west of Paris. (Compt. Rend., 106: 1590.) The construction is progressing rapidly, and when completed this will be one of the best equipped observatories in the southern hemisphere.

Leipzig (University Observatory).—The zone observations $+5^\circ$ to $+15^\circ$ are practically finished. A new Repsold heliometer of 162 millimeters aperture was mounted in 1886, and is described, together with its new dome, at some length in Dr. Bruns' report for 1887; an important addition to the working force is Herr "Mechaniker" Lohm.

Leipzig.—Dr. Engellman devoted most of his time to measures of double stars.

Lick.—An important event of the year 1888 was the transfer, on June 1, of the Lick Observatory to the regents of the University of California. The equipment of the Lick Observatory has been previously described in these reports and elsewhere, but it may not perhaps be superfluous to recapitulate briefly here, referring for details to Vol. 1 of the observatory publications, or to an article by Professor Holden in the Sidereal Messenger for February, 1888. The mounting of the 36-inch equatorial is referred to at some length in the present report under the heading "INSTRUMENTS."

The main observatory building is 287 feet long, including the 75 foot dome at its southern end, and contains a hall 12 feet wide running the whole length, offices and computing-rooms, the library, clock-room, visitors' room, etc., and at the northwest corner stands the 25-foot dome for the 12-inch equatorial. The other buildings on the mountain summit are the meridian-circle house, transit-house, photoheliograph, laboratory, several temporary workshops, and the dwelling for the astronomers. The instrumental equipment consists of the 36-inch, 12 inch, and 6½-inch equatorials, 4-inch comet-seeker, 6 inch meridian-circle, 4-inch transit and zenith telescope, 2-inch universal instrument, photoheliograph, declinograph, five clocks, several chronometers, four chronographs, and minor apparatus. The cost of the instruments with their mountings and transportation, aggregated about $200,000; buildings and other expenses amounted to about $375,000; leaving in the neighborhood of $125,000 for a permanent endowment fund. In addition to what may be derived from the investment of this sum, the observatory is to be allowed for its maintenance as a department of the University of California the sum of $19,188 a year. The astronomical staff consists of E. S. Holden, director and astronomer; S. W. Burnham, J. M. Schaeberle, J. E. Keeler, E. E. Barnard, astronomers; C. B. Hill, assistant astronomer, secretary, and librarian. The first volume of "Publications" appeared before the real work of the observatory had begun, and it is, therefore, mainly historical and descriptive. It contains Mr. Lick's deeds of trust, Professor Newcomb's report on glass for objectives, Mr. Burnham's reports upon the site in 1879 and 1881, descriptions of the buildings and instruments, an account of the engineering and building at Mount Hamilton in the years 1880–1885, observations of the transit of Mercury in 1881 and of Venus in 1882, geological reports, meteorological observations, 1880–1885, and an extensive series of reduction tables for the latitude of the observatory. There have been published in scientific journals and in the daily press interesting notes upon nebulæ and planetary markings as shown by the 36-inch refractor, and the discoveries of new comets and double stars. Professor Holden attributes the steady-seeing at Mount Hamilton to the coast fogs, which roll in from the sea every afternoon in the summer, rising 1,500 to 2,000 feet, covering the hot valley and preventing radiation from it. The nights of summer and autumn—April to October or November—are found to be excellent both as to clearness and steadiness; the daylight hours are less satisfactory, and in winter the seeing is not much better than at lower altitudes.

Liège (*Ougrée*).—See Cointe.

Litchfield.—Dr. Peters is still at work upon his ecliptic charts; he expects to issue shortly a second installment of twenty.

Liverpool.—The time-gun has been fired with regularity, chronometers tested, and meteorological observations conducted as heretofore.

Lund.—Dr. Dunér has continued his observations of variable stars and spectra of red stars, and with a large solar spectroscope, provided with one of Rowland's gratings, he has made an important investigation of the period of rotation of the sun. Photographs of the solar spectrum were made as a check upon the micrometer measures.

Lyme Regis.—See Rousdon.

McCormick.—The 26-inch equatorial is still devoted chiefly to the study of nebulæ. Mr. Leavenworth resigned as assistant in September, 1887, to take charge of the Haverford College observatory. Professor Stone expresses continued satisfaction with the electric illumination of the equatorial.

Madras.—Mr. Norman R. Pogson has published in two volumes the results of a series of observations of star places made with the 5½-inch meridian circle, the first volume giving, after a brief history and description of the observatory, the "separate results" and annual catalogues for 1862, 1863, and 1864, and the second volume "separate results" and annual catalogues for 1865, 1866, and 1867.

Mauritius.—Principal activity is in the observation of meteorological and magnetic phenomena, and in the photographic record of the state of the solar surface by means of the photoheliograph.

Mazatlan (Sinaloa).—Founded in 1879 and intended principally for the time service, and is supported by the department of public works. Its directors have been: Ingo. Fiacro Quijano, 1879–'84; L. Gutierrez, 1884; F. Weidner, 1884; C. Camiña, 1885–'87; L. Acosta, 1887. Instruments: Meridian instrument, by Fauth & Co., aperture $0^m.076$ (3 inches), focal length $0^m.787$ (31 inches); equatorial, by W. Gregg, New York, $0^m.15$ (6 inches), aperture; Troughton & Simms altazimuth, and Negus chronometer. Latitude, $+23° 11' 22''.81$; longitude, $7^h 5^m 35^s.67$ west of Greenwich.

Melbourne.—The mirrors of the 4-foot Cassegrainian reflector have become so tarnished as to interfere materially with the observation of the fainter nebulæ. The sum of $5,000 has been appropriated to enable the observatory to take part in the stellar photographic scheme of the Paris conference.

Mexico.—The Central Astronomical Observatory in the city of Mexico was founded in 1878. It is intended for purposes of instruction, and especially for co-operating in geodetic work and for maintaining the time-service of the capital. The principal instruments are a meridian telescope, by Troughton & Simms, of $0^m.069$ aperture and $1^m.16$ focus; a zenith telescope, by the same makers, of $0^m.076$ aperture $1^m.22$ focus; an altazimuth, by the same, with $0^m.305$ (12-inch) circles; a small Buron refractor, Fauth chronograph, sidereal clock by Vasquez, two Bliss break-circuit chronometers, several mean-time chronometers, and a fillet chronograph. The director has also under his charge the geodetic, topographic, and astronomical instruments of the department of public works. Position of the observatory: Latitude, +19° 26′ 1″.3; longitude, 6^h 36^m $31^s.5$; altitude, $2,285^m.4$ (7,500 feet). Directors: Sr. Ingeneiro Geografo Don Francisco Jiminez from 1878 till his death, November 4, 1881, when he was succeeded by Sr. Don Leandro Fernandez.

Milan.—A new 18-inch refractor, objective by Merz, mounting by Repsold, was put in place in 1886, and has been devoted principally to the measurement of double stars. The smaller (8 inch) equatorial has been used for observations of comets and of double stars in rapid orbital motion. The markings on Mars were examined with both instruments.

Morrison observatory was established in 1875 through the efforts of the present director, Prof. C. W. Pritchett, aided by the liberality of Miss Berenice Morrison, whose name the institution bears. The principal instruments are a 12¼-inch Clark equatorial and an excellent 6-inch Troughton & Simms meridian circle, similar in plan to the meridian circle of the Harvard Observatory. The first number of the publications is a well printed volume of 111 pages, giving an account of the founding of the observatory, a full description of the building and instruments, and the observations in detail. The latter consist mainly of measures of double stars, observations of planets, comets, occultations by the moon, etc. A full discussion is given of the geographical co-ordinates of the meridian pier, the longitude being determined by an exchange of signals with Washington in 1880. There are several drawings of the observatory, and sketches of Saturn and of comets. The work is now much restricted owing to the inadequacy of funds.

Munich.—The zone observations with the meridian circle are continued, and a new Munich catalogue is going through the press. The 10½-inch refractor has been used for observations of comets, measures of stars in the cluster *h* Persei, and observations for stellar parallax. Some photometric observations have also been made.

Natal.—Recent work has been largely in meteorology. The observatory has been seriously crippled by the lack of funds.

Nice.—The first volume of the annals is to contain a description of the observatory and instruments, and is expected shortly; the second volume has already been published, and the third volume, also in preparation, will contain Thollon's study of the solar spectrum. Vol. 2 is devoted mainly to the determination of the co ordinates of the observatory and to measures of double stars. There are also observations of comets and planets, and notes on solar spectroscopy and the red-glows. The position of the observatory at present adopted is: Latitude, + 43° 43′ 16″.9; longitude, 0^h 19^m $51^s.22$ east of Paris.

North Carolina University.—Professor Love, of the University of North Carolina, Chapel Hill, has called attention to an early attempt to establish an astronomical observatory in the United States which seems to have remained unnoticed by astronomers. Professor Caldwell, the president of the university, went to Europe in 1824 to purchase books and apparatus, and spent the greater part of $3,361.35 for astronomical instruments; this was four years before the purchase of a telescope by Yale. The foundations of the observatory were laid in 1831, and the building was finished in 1832, six years before the Hopkins Observatory at Williams. There was but one room, 15 feet by 25 feet and about 25 feet high. A Simms transit of 3-inch aperture and 44-inch focus was mounted upon a masonry pier in this room, and a Simms altitude and azimuth instrument upon a pier projecting through the roof and covered by a small house moving on rails. The observatory possessed also a 2½-inch (52-inch focus) Dolland refractor, an astronomical clock by Molyneaux, reflecting circle, sextant, and quadrant. The instruments were removed from the observatory owing to a leaky roof, soon after Dr. Caldwell's death, in 1835, and in 1838 the building was partly destroyed by fire, and astronomical activity was never renewed. All records of observations have been lost.

Oakland.—The private observatory of Mr. F. G. Blinn, in East Oakland, contains a 5-inch Clark equatorial and 1¾-inch Latimer-Clark transit, with mean-time and sidereal clocks.

Oakland.—The observatory of Mr. Burckhalter, at West Oakland, California, contains a 10½-inch reflector by Brashear, and 1⅝-inch transit. The mechanical work of the building and equatorial mounting was done by the owner.

O'Gyalla.—Observations of sun spots, spectroscopic and photometric observations of planets, new stars, comets, and stars with variable spectra. The observations for a "spectroscopic Durchmusterung" from 0° to −15° declination have been finished and the catalogue printed. Dr. von Kövesligethy, Dr. von Konkoly's assistant, accepted a position in the meteorological office in Budapest, April 1, 1887. Considerable spectroscopic and photographic apparatus has been added to the equipment.

Omaha, Nebraska.—A new observatory at Creighton College was completed in 1887. The instruments are a 5-inch Steward equatorial, 3-inch Fauth transit, clocks, chronograph, etc. Director, J. Rigge, S. J. Latitude, +41° 16′ 6″; longitude, $6^{h}\ 23^{m}\ 47^{s}$ west of Greenwich.

Orwell Park.—An extensive and valuable series of observations of recent comets has been published.

Oxford University.—Great attention has been paid to photography, and particularly to its application to the determination of stellar parallax (*q. v.*), with very gratifying results. The large equatorial is to be re-modelled as a photographic telescope of 13 inches aperture in conformity with the plans adopted by the Paris congress, the necessary funds having been provided by Dr. De La Rue.

Palermo.—Observations of comets, planets, sun spots, and meteors.

Paris.—The approaching completion of the observations for the Lalande catalogue has modified the plan of operations carried on with the meridian instruments for some years past. The large transit circle has been used for observations of the sun, moon, minor planets, and such stars of Lalande's list still requiring re-observation; the Gambey transit, for observations of the absolute right ascensions of fundamental stars; the Gambey circle and the "cercle du jardin," for a re-investigation of the latitude, and the latter also for fundamental declinations. Comets, asteroids, nebulæ, and occultations of stars by the moon have been observed with the equatorials. The most important addition to the instrumental equipment is the apparatus adapted to the equatorial *coudé* for determining the constants of refraction and aberration by Loewy's method. Work in astronomical photography is continued by the Henrys. A fine engraving of the Pleiades, compiled from three of their photographs, accompanies Admiral Mouchez's report for 1887. The time service, which of late has not been entirely satisfactory, is undergoing renovation.

Paris (*École militaire*).—M. Bigourdan gives in the Bulletin Astronomique (4 : 497; 5 : 30) an interesting historical account of the observatories of the École militaire, famous for the labors of Lalande and d'Agelet.

Pekin.—An interesting historical account of this observatory (established in 1279) is given in abstract, in Nature for November 8, 1888.

Phelps (*New York*).—The Red House Observatory was abandoned in 1888, Mr. Brooks having become director of the Smith Observatory at Geneva.

Poona.—An observatory has been established at the College of Science with a 16½-inch silver-on-glass Newtonian reflector by Grubb, 6-inch refractor by Cooke, with photographic, photometric, and spectroscopic accessories. It is intended at present to restrict the work of the observatory to certain branches of spectroscopic research, with occasional observations of comets, etc. The curator is Mr. K. D. Naegamvala.

Potsdam.—Dr. Vogel has applied photography to the determination of the motions of stars in the line of sight, and has obtained most satisfactory results. He proposes to observe regularly all stars (about sixty) that are as bright as 2.5 magnitude. The observations of solar phenomena, sketches, and photometric observations of comets and planets have been continued with little interruption. Progress is reported upon the "photometric Durchmusterung," which is to take in all stars in the northern hemisphere down to the 7.5 magnitude. The instruments required to enable the observatory to take part in the photographic work planned by the Paris congress have been ordered, and numerous preliminary experiments have been carried out for the permanent committee of that body.

Prague.—Professor Safarik has continued his observations of variable stars. In 1887 he changed his residence, and made considerable improvements in his observatory. The instruments are a 6-inch refractor, which is to be replaced by one more powerful, and a small transit and clock. The provisional co-ordinates of the meridian room are: latitude, +50° 4′ 21″; longitude, 0^h 57^m 48^s east of Greenwich.

Puebla (*Mexico*).—Observatory of the College of the Sacred Heart. Director, P. Capelleli, S. J.

Pulkowa.—The great routine work of the observatory, the determinations of star positions with the transit, meridian circle, and vertical circle has proceeded on the same lines as before. Romberg is credited with having made no less than 9,000 observations with the meridian circle in a single year. The 30-inch refractor has been used on close double stars and satellites, the 15-inch on similar work, and also for experiments in stellar photography. The astro-physical laboratory is reported in working order. Volume 12, a catalogue of the principal stars to the fourth magnitude, as far as −15° declination, has been published, and several other volumes, though interrupted by the death of Wagner, are well advanced. The first number of a new series of publications—"Supplements to the Pulkowa Observations"—is an interesting memoir by Dr. Hermann Struve on the outer satellites of Saturn.

Radcliffe.—The transit circle has been used for observing the sun, moon, and a list of stars down to the seventh magnitude between the equator and −25°; the Barclay equatorial for the measurement of double stars and observations of comets. The volume for 1885 has been published, and all reductions are remarkably well advanced.

Rousdon.—Systematic observation of some twenty long-period variables has been taken up; time signals are furnished for the neighboring district.

Scholl Observatory.—At Lancaster City, Pennsylvania, a new observatory, named the Daniel Scholl Observatory, has been erected on the grounds of Franklin and Marshall College. The equipment as described by Mr. J. E. Kershner in Science for May 13, 1887, consists of an 11-inch Clark-Repsold equatorial, a 3-inch transit, a Seth Thomas clock, a chronometer, chronograph, and meteorological apparatus. The equatorial has a set of positive and negative eye-pieces, with reversion prisms for three of the micrometer eye-pieces, a Mertz solar eye-piece, and a comet eye-piece, together with a micrometer and complete illuminating apparatus for bright and dark field, as worked out by the Repsolds.

Smith College (*Northampton*).—An exchange of longitude signals with the Harvard Observatory was made in the summer of 1888.

Stockholm.—Dr. Gyldén has devoted himself to investigations in celestial mechanics.

Stonyhurst College.—The solar observations consist of (1) a drawing of the sun's disk, 10½ inches in diameter, including the careful delineation of all spots and faculæ visible; (2) a spectroscopic measurement with a radial slit of the height of the chromosphere and of all the gaseous prominences; (3) a study of the general surface of the sun whenever the definition has been unusually good; (4) a sketch of the chromospheric flames, with a wide tangential slit; (5) the spectrum of the solar spots between the lines B and D. Observations of lunar occultations, of comets, and of the phenomena of Jupiter's satellites have been made as before. The sky-glows have also been watched with care. A 5½-inch Clark equatorial, formerly the property of Rev. T. W. Webb, was purchased for the observation of the total solar eclipse of August 29, 1886.

Strassburg.—Dr. E. Becker was appointed director December 1, 1887, relieving Dr. Kobold, the "observator," temporarily in charge. Observations of nebulæ, comets, and satellites have been made with the refractor; observations of the sun, moon, and planets and of zero stars for the southern zones with the meridian circle, and measures of the sun's diameter and sunspots with the heliometer. The transit instrument has been used by Dr. Wislicenus for investigations with a personal equation apparatus of his own design. All reductions are well advanced. The library has been thoroughly overhauled and recatalogued.

Syracuse (New York).—The new observatory of the University of Syracuse, a memorial to Charles Demarest Holden, of the class of 1877, was dedicated November 18, 1887, with an appropriate address by Professor Newcomb. The instruments are an 8 inch Clark equatorial, 3-inch Troughton and Simms transit, clock chronograph, and chronometer. Director, Prof. J. R. French.

Syracuse (New York.).—Private observatory of H. P. Stark; $5\frac{5}{16}$-inch Spencer equatorial refractor; 12-foot dome.

Tacubaya.—The National Mexican observatory, which is in the department of the secretary of public works, was founded May 5, 1878, The instruments were at first mounted at Chapultepec, but in 1883 they were transferred to the present building, erected at a cost of $200,000. The instruments are as follows: A refractor of $0^m.381$ (15 inches) aperture and $5^m.40$ (17 feet 8 inches) focal length, by Grubb, provided with a fine micrometer and an 11-prism spectroscope; a meridian circle of $0^m.203$ (8 inches) aperture and $2^m.743$ (9 feet) focal length, by Troughton & Simms, with circles $0^m.914$ (36 inches) in diameter, divided to 5′ and read by four microscopes, and with collimators of $0^m.152$ (6 inches) aperture and $2^m.15$ (7 feet) focus; a Dallmeyer photoheliograph of $0^m.102$ (4 inches) aperture and $1^m.53$ (5 feet) focus, with parallactic mounting and an enlarging apparatus; an alt-azimuth, also by Troughton & Simms, of $0^m.083$ (3¼ inches) aperture and $0^m.85$ (2 feet 9 inches) focal length, with circles $0^m.60$ (2 feet) in diameter, divided to 5′. In addition to these there are, not yet mounted, a Grubb equatorial of $0^m.152$ (6 inches) aperture and $2^m.54$ focal length, an Ertel meridian instrument of $0^m.152$ aperture and $2^m.20$ focal length, and a Troughton & Simms zenith telescope, $0^m.076$ aperture and $1^m.15$ focal length. Of subsidiary apparatus there is a cylindrical chronograph, Barraud & Lund; a fillet chronograph, made in 1867 by direction of Commodore Maury; a sidereal clock, by F. Vazquez, Mexico; sidereal and mean-time clocks, by Barraud & Lund; two sidereal chronometers, by Negretti & Zambra; seven mean time chronometers, by various makers, and magnetic and meteorological instruments. A photographic refractor of $0^m.33$ (13 inches) aperture and $3^m.43$ (11 feet) focal length has been ordered from Grubb, to enable the observatory to co-operate in the international plan of charting the sky by photography. The personnel consists of Sr. Ingeneiro Angel Anguiano, director; Sr. Ingeneiro Felipe Valle, Sr. Lieut. Col. Teodoro Quintana, Sr. Ingeneiro Francisco Rodriguez Rey, Sr. Apolonio Romo, Sr. M. Moreno; two more astronomers will be added during 1889. The work of the meridian circle has been upon comparison stars, comets, and asteroids; the 15-inch equatorial has been used upon comets, and asteroids, and these bodies, as well as a list of southern nebulæ, will be carefully observed in future. The photoheliograph has been used almost daily, and with the alt-azimuth observations for time and latitude have been made, and observations of lunar culminations and of comets. Considerable time has been devoted to co-operating with longitude parties. The position of the observatory is: Latitude, $+19° 24' 17''.5$; longitude, $6^h 36^m 46^s.53$ west of Greenwich (determined telegraphically from St. Louis); altitude $2,322^m$ (7,618 feet). An "anuario" is published regularly.

Tacubaya.—Private observatory of M. G. Prieto: Bardou equatorial, $0^m.11$ (4⅓ inches) aperture, $1^m.60$ (5 feet 3 inches) focal length; spectroscope, and clock.

Taschkent.—The refractor has been used for observations of sun-spots, comets, and occultations by the moon; the meridian circle, principally for determining the positions of comet comparison stars. The observatory has co-operated in determining the geographical positions of a number of places in central Asia. Several chronometers have been tested, and the noon signal has been given by the discharge of a cannon, as in previous years. The director, M. Pomerantzeff, is assisted by MM. Zalessky and Schwarz. A new determination of the latitude in 1887 gave: $\varphi = +41° 19' 31''.35 \pm 0''.05$.

Temple observatory (*Rugby*).—Spectroscopic observations of the motion of stars in the line of sight, and measures of double stars.

Tokio.—An observatory was founded in 1888 at Tokio, Japan, by combining the astronomical department of the old Marine observatory, the observatory of the Ministry of the Interior, and that of the Imperial University. The new observatory occupies the buildings of the Marine observatory, its position as provisionally determined being latitude, $+35° 39' 17''.5$; longitude, $9^h 18^m 58^s.0$ east of Greenwich. The principal instruments are a 5¼-inch Repsold transit, a 5 inch Merz and Repsold meridian circle, and equatorials of 6½ and 8 inches aperture. The director is H. Terao.

Turin.—Observations of comets, meteorological observations, and a determination of the latitude of a station at Termoli have been published.

United States Naval Observatory.—The work of 1887–'88 was similar to that of previous years. With the 26-inch equatorial observations were made of double stars, satellites, and of Saturn and Mars, and observations for stellar parallax; with the 9.6-inch, observations of comets and asteroids. The observations with the transit-circle for a catalogue of miscellaneous stars were completed in 1888, and preparations have been made for observing with this instrument the zone −14° to −18°. The time-service has been considerably extended. The contract for the erection of the nine buildings comprising the new observatory was awarded in 1888, and some progress has been made with the necessary excavations.

Upsala.—Dr. Hermann Schultz describes at some length in the Vierteljahrsschrift (23: 144) the recent additions to his instrumental outfit: a transit and a vertical circle, both by Repsold, with objectives of 95^{mm} (4 inches) aperture; a transit, by Steinheil, of 54^{mm} (2 inches) aperture, mounted in the prime vertical; a 4-inch refractor, parallactic mounting, by Simms; clock Hohwü 34, three chronometers, two chronographs, and minor apparatus. The principal instrument of the observatory is a 9-inch refractor.

Vassar College.—Miss Mary W. Whitney has been appointed to fill the vacancy caused by the resignation of Miss Maria Mitchell.

Vienna (*Wien-Ottakring*).—The private observatory of Herr von Kuffner, which was begun in 1884, was completed in 1887. The building is in the shape of a cross, 82 feet from east to west and 61 feet from north to south. The instruments are: A meridian circle, by Repsold, of 4.8 inches aperture and 5 feet focal length, with circle 21.6 inches in diamter, divided to 2′ and read by four microscopes; and a refractor, also by Repsold, of 10.6 inches aperture and 12½ feet focal length, with filar, double image, and ring micrometers. The position of the obsertory, as provisionally determined by Dr. Herz, is: Latitude, +48° 12′ 47″.2; longitude, $1^h\ 5^m\ 11^s.1$ east of Greenwich.

Warner (*Rochester, New York*).—Search for new nebulæ.

Washburn.—The fifth volume of publications contains the observations made with the meridian circle by Miss Lamb and Mr. Updegraff from the latter part of 1886 to April 1, 1887, observations made with the 15½-inch equatorial, and a summary of meteorological observations made by various observers at Madison from 1853 to 1886. Miss Lamb contributes a very useful index to stars in Airy's six Greenwich catalogues not found in Flamsteed, and Mr. Updegraff a discussion of the latitude of the observatory. Professor Davies was succeeded by Prof. G. C. Comstock as director, and Prof. Asaph Hall as consulting director. Mr. Updegraff and Miss Lamb (now Mrs. Updegraff) have removed to the Cordoba observatory. The assistants now at the observatory are

Mr. H. V. Egbert, formerly of the Albany observatory, and Prof. S. J. Brown. The free use of the Washburn observatory was tendered to the Navy Department during the contemplated removal of the naval observatory to its new site.

West Point.—A new observatory was built in 1883, the old site having been rendered worthless as an astronomical station by a railroad tunnel cut immediately beneath it. The instruments are a 12-inch Clark equatorial, mounted in 1884, and an 8-inch Repsold meridian circle, mounted in 1885. Geographical position: Latitude, +41° 23′ 22″.1; longitude, $4^h\ 55^m\ 50^s.6$ west of Greenwich. Height above sea level, 480 feet.

Williams College.—On the 28th of June 1888, the fiftieth anniversary of the dedication of the Hopkins Observatory of Williams College was celebrated with suitable ceremony and a discourse upon "The Development of Astronomy in the United States," by Prof T. H. Safford. The Hopkins Observatory seems entitled to the honor of being the first permanent American observatory, having been projected about 1831, chiefly built in 1837, and dedicated June 12, 1838. The University of North Carolina had built an observatory in 1831 and provided an excellent instrumental equipment, but in 1838 the building was partially destroyed by fire, and little or no astronomical work was ever done with the instruments. Professor Safford published in 1888 a catalogue of the right ascensions of some 261 circumpolar stars, the results of several years' labor with the Repsold meridian circle.

Wilmington, Delaware.—The private observatory of Francis G. du Pont is at his residence about 4 miles to the north of Wilmington, Del. It was designed by the owner, and consists of two polygonal buildings, covered by domes of peculiar construction, and connected by a third building, which forms the transit room. The instruments are: A good 12-inch reflector by Brashear, well mounted, with driving-clock, etc.; a 4½-inch equatorial refractor, objective by Clark and mounting by Brashear; a small transit by Horne & Thornethwaite, London; sidereal and mean time clocks, and Morse register for recording transits. The whole building is lighted by the electric light, and the electric light is also used for instrumental illumination. The 12-inch reflector has been used for astronomical photography. The approximate latitude is +39° 16′.

Windsor, New South Wales.—Mr. Tebbutt published in pamphlet form in 1887 an interesting history and description of his observatory. It is situated, with the owner's residence, at the eastern extremity of the tow of Windsor, upon a hill 50 feet above mean tide. Occasional astronon ical observations were made here with a sextant and 1⅝-inch telescope fro m 1854 to 1864. To these instruments were added a 3¼-inch refractor by Jones in 1861, and a Frodsham chronometer in 1864. At the close of 1863 a small building, comprising transit and prime vertical rooms and a don e, was erected on the west of the dwelling, and a small transit and the 3¼ -inch refractor already referred to were mounted. This refractor gave place to one of 4½ inches aperture in 1872, and in 1874 a further addition was made to the buildings. In 1879 a substantial observatory of brick was erected a few yards southwest of the old building. It consists of an equatorial room (under which is an office) and meridian and prime vertical rooms, the meridian room containing a Cooke transit, mounted in 1879. In 1882 an 8-inch Grubb equatorial supplanted the 4½-inch. Mr. Tebbutt has published many valuable observations of comets, asteroids, double and variable stars, occultations of stars by the moon, etc., during the more than twenty-five years' existence of his observatory.

Wolsingham.—Rev. T. E. Espin has continued his sweeps for red stars and stars with remarkable spectra, and has announced the discovery of several new variables. A 4.8-inch Troughton & Simms eqatorial has been added to the equipment, and a new edition of Birmingham's red star catalogue has been published. In the latter part of 1888 the observatory was removed to a new site at Towlaw, Darlington, 3 miles northeast of its old position and 1,000 feet above sea-level.

Yale.—The initial volume of "Transactions of the Astronomical Observatory of Yale University," a valuable memoir by Dr. W. L. Elkin upon the relative positions of the principal stars in the Pleiades, as determined with the new heliometer, was published in 1887, the expense of printing having been borne by Professor Loomis. Upon the completion of this work Dr. Elkin took up the investigation of the parallaxes of the ten first-magnitude stars in the northern hemisphere, and the results obtained we have already referred to under stellar parallax. The heliometer has also been used for measures of various double stars and of the diameters of the sun and Mars, and more recently in a triangulation of twenty-four stars within 100′ of the north pole, and in observations of Iris for the determination of the solar parallax. Mr. Hall has nearly completed the reduction of his work upon Titan, the expense of which is defrayed by the Bache fund, and he has taken up the investigation of the parallaxes 6 B Cygni and Lalande 18115, 22. Mr. O. T. Sherman, who had charge of the thermometric bureau, resigned in November, 1886, and his work has since been carried on by Mr. Peck. The testing of time-pieces has been discontinued, but the time-service is still maintained. The subscription of $1,000 annually for the support of the work with the heliometer has been renewed for three years, beginning with 1887.

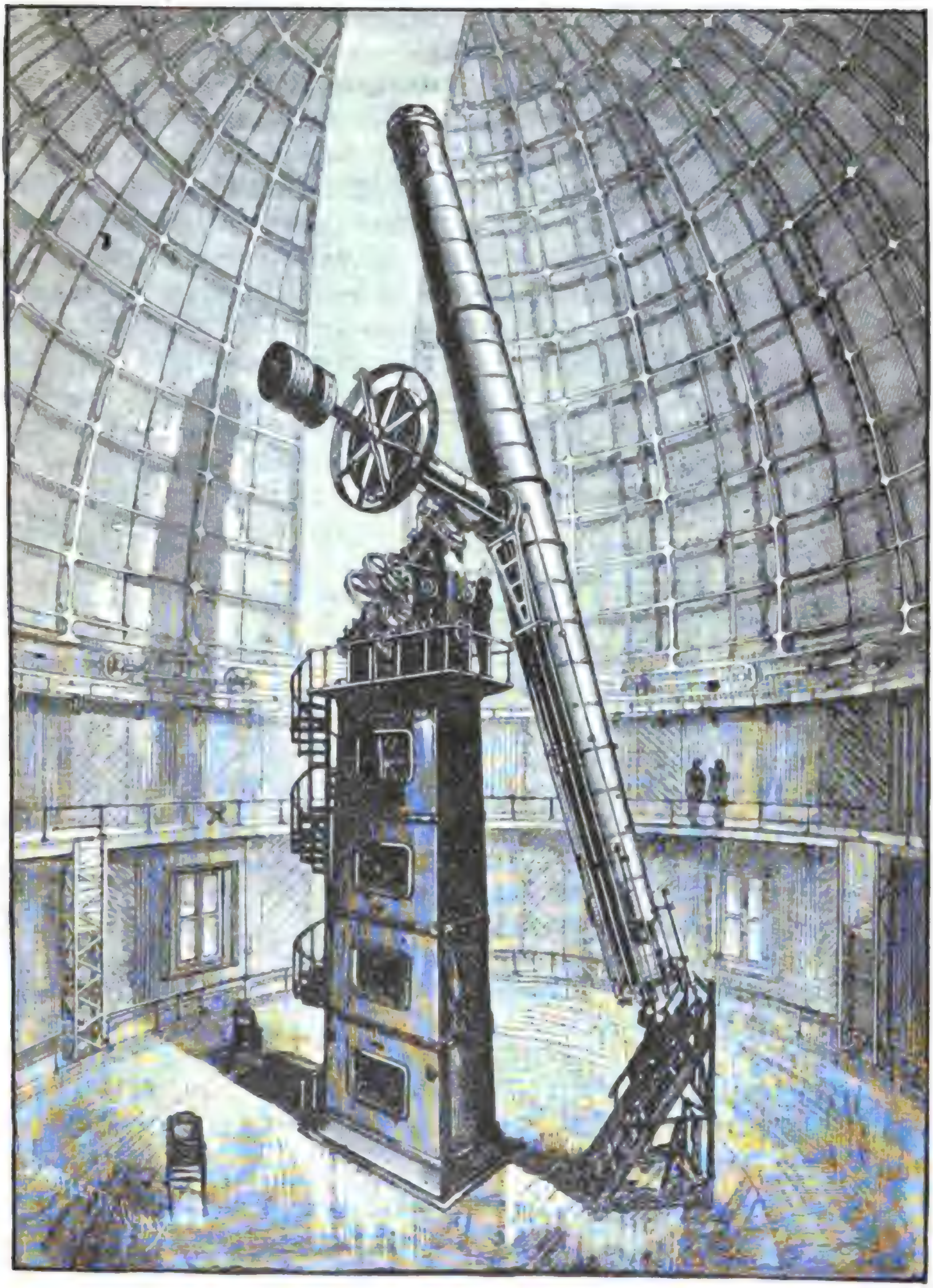
Zacatecas (*Mexico*).—Latitude +22° 46′ 34.″9, longitude $6^h\ 50^m\ 17.^s5$ west of Greenwich; altitude $2,475^m$ (?). Instruments: Equatorial of 6 French inches aperture with astronomical and photographic objectives, a small transit, altazimuth, clock, chronometer, spectroscope, and meteorological apparatus. Director, Ingeneiro José A. y Bouilla.

Zürich (1886).—Dr. Rudolf Wolf has continued his observations of sun-spots.

ASTRONOMICAL INSTRUMENTS.

The 36-inch Lick telescope.—The great equatorial was mounted in 1887. The visual objective has a clear aperture of 36 inches and focal length of 56 feet 6 inches. The flint disk for this objective was obtained by Clark from Feil & Co., of Paris, in 1882, the crown in 1885, and the objective was completed and delivered by Clark in 1886. These two disks are separated in their cell by a space of 6.5 inches. In 1887 a third (crown) lens of 33 inches aperture and 46 feet focus was procured as a "photographic corrector." The mounting was made by Warner & Swasey, of Cleveland, Ohio, and put in place in the autumn of 1887. The pier is a hollow cast-iron column of rectangular section, and for convenience in transit is built up of five sections, bolted together by internal flanges. At the top the column measures 4 feet by 8 feet, increasing to 5 feet by 9 feet at the floor line, and then spreading out rapidly to a base 10 feet by 16 feet bearing on a masonry foundation. At this point the weight is distributed over a series of large steel screws, which afford the means of adjusting the position of the polar axis. At the top of the column is the head carrying the bearings for the polar axis, and around the head is a balcony reached by a spiral staircase. The intersection of polar and declination axes is 37 feet above the base. Column and head weigh together 21 tons, and the total weight of the telescope is 40 tons. The tube consists of a central section of cast-iron, strongly ribbed, to which two sections of sheet-steel are attached. The diameter of the tube is 4 feet at the center, 38 inches at the object-glass end, and 36 inches at the eye end, while the sheet-steel portions vary from one-eighth of an inch thick at the center to one-twelfth of an inch thick at the ends. When the telescope is in a horizontal position the flexure of the tube with the object glass and permanent counterbalance is one-eighth of an inch only, while with a load of 1 ton added at each end the flexure is increased to one-quarter of an inch.

The polar axis is of steel, 10 feet long, 12 inches in diameter at its upper and 10 inches at its lower end, with a 6-inch hole through its entire length; the bearings are of Babbitt metal, relieved by anti-friction rolls. The declination axis is also of steel, 10 feet 6 inches long, 10 inches tapering to 9½ inches diameter, with a 4-inch hole running through it; Babbitt-metal bearings, with anti-friction rolls, upon hard steel balls are used, as in the polar axis. To facilitate counterpoising the telescope is arranged for carrying always its maximum load, so that when the photographic corrector, the spectroscope, or any physical apparatus is attached an equivalent weight is taken off at the same place. There are three regular finders of 6, 4, and 3 inches aperture; in addition to these the 12-inch equatorial can be quickly attached as a pointer for photographic work if necessary. The hour circle on the polar axis is 3 feet in diameter, and has coarse graduations to 5 minutes, and large figures on its outer edge, while on the northern face it is graduated to 20 seconds. Attached to the head, at the upper end, is a fixed hour



THE LICK TELESCOPE.

Length, 57 feet. Diameter of Object-glass, 36 inches. Total weight, 40 tons.
Warner & Swasey, designers and builders. Object glass by Alvan Clark & Sons.

circle graduated to 20 seconds and read through a series of prisms, at the eye end to 4 seconds. On the declination sleeve near the tube is a fine declination circle 3 feet in diameter graduated to 5 minutes of arc, and read from the eye end to 12 seconds, while on the outer end of the axis is a coarse declination circle 6 feet in diameter graduated to degrees. The driving clock is regulated by a frictional governor of the cross-armed type and by an electric control from the standard clock. One of the shafts carries a chronograph drum. For photographic work an opening is cut in the side of the tube about 10 feet from the eye end, and a plate 20 inches square can here be inserted and suitably adjusted. The eye end is so arranged that the micrometer can be quickly removed and two steel bars inserted in bearings. These bearings are part of a jacket revolving 360° in position angle, and to them can be attached spectroscopes, photometers, enlarging cameras, etc. The eye end is also surrounded by a large ring, which supports the various handles for actuating the clamps and slow motions, and carries the reading microscopes and finders as well as a small sidereal chronometer. The clamps and slow motions are operated as follows:

An observer at the eye end can—

(1) Clamp in declination.
(2) Give slow motion in declination.
(3) Read the declination circle (two verniers).
(4) Clamp in right ascension.
(5) Stop the clock.
(6) Give slow motion in right ascension.
(7) Read right ascension circle (one microscope).

An assistant on either side of the balcony below the axes can—

(8) Clamp in declination.
(9) Give rapid motion in declination.
(10) Give slow motion in declination.
(11) Give quick motion in right ascension.
(12) Give slow motion in right ascension.
(13) Clamp in right ascension.
(14) Stop or start the driving clock.
(15) Read the right ascension circle (two microscopes).
(16) Read a dial showing the nearest quarter degree of declination.

Detailed drawings of the mounting are given in Engineering, volume 46, London, 1888.

The almucantar.—In volume 17 of the Annals of Harvard College Observatory, Mr. S. C. Chandler, jr., has given a complete description and investigation of his "almucantar," and a discussion of a series of observations made with it in 1884 and 1885. The almucantar, as its name implies, is an equal altitude instrument, and was devised by Mr. Chandler in 1879. It consists, essentially, of a telescope attached to a frame-work which is floated on a small quantity of mercury contained in a shallow trough. The trough is supported on an upright pillar, and can be turned about a vertical axis, and set with the telescope it carries to any azimuth. If the telescope is clamped at a given altitude, the sight line will mark accurately in the heavens a parallel of altitude, or "almucantar," and the observation of the time of transits of stars as they rise or fall over this circle in different azimuths will furnish the means of determining instrumental and clock corrections, the latitude, or right ascensions and declinations. The particular parallel of altitude which has been found most convenient, as it materially simplifies the formulæ of reduction, is the parallel passing through the pole, to which the name "co-latitude circle" is given. Mr. Chandler gives the mathematical theory of the new instrument, and illustrates the various formulæ for reducing observations by numerous examples. He then proceeds to examine critically the results of his observations (which are given in detail in the last chapter), and to describe a number of experiments on the stability of the instrument. He also suggests several modifications of construction, which he hopes in time to incorporate in a more complete form of the apparatus.

The almucantar as a field instrument seems to possess many advantages over the transit and zenith telescope for the determination of time and of terrestrial latitudes and longitudes, and Mr. Chandler states that it can be constructed at a much less cost than these instruments; but for the determination of accurate positions of the fixed stars—a class of work for which meridian instruments have hitherto been exclusively employed—it offers a new and independent method, free from many of the systematic errors inherent in the older system. The remarkable results that Mr. Chandler has already obtained with his instrument of only about 4 inches aperture certainly justify great confidence in the "almucantar system."

Horizontal telescope.—Professor Pickering has had made for the Harvard Observatory a horizontal telescope of 12 inches aperture and 17 feet focal length, possessing some of the conveniences of the equatorial coudé. The tube is placed east and west, the object-glass at the western end. Before the object-glass is a plane mirror 18 inches in diameter, so mounted that the light of a celestial object not more than one hour on either side of the meridian can be thrown by its means into the field of the telescope. A small building covering the eye-piece at the eastern end protects the observer, and may be heated in winter so that he can work in comfort. The instrument may be used for almost any class of observations, but is intended primarily as a photometer, and with this end in view an auxiliary telescope of 5 inches aperture is employed to bring into the field an image of the Pole-star, which is reduced by polarizing apparatus to equality with the image of a star observed in the principal telescope. The angular apertures of the two telescopes are such that the emergent pencils are coincident.

A device adopted at Greenwich in the observations of occultations during the eclipse of the moon on January 28, 1888, seems worthy of record. The eye-piece of the telescope was mounted eccentrically from the axis at the distance of the moon's radius, so that, without disturbing the position of the telescope, any point of the limb could be brought into the center of the field. For setting the position-circles rapidly in the dark, card-board circles, with notches cut at important points which could be felt with the fingers, were used; and in another case luminous paint was found to work admirably for indicating the figures.

In the report of the Melbourne Observatory Mr. Ellery describes a form of micrometer used successfully on the great reflector for making sketches of nebulæ. It consists of a number of silver threads crossing at right angles, and rendered visible at will by means of an electric current.

M. Périgaud has found that the essential condition in the artificial horizon devised by Gautier for the meridian work of the Paris Observatory is that the mercury should form an extremely thin covering upon the bottom of the containing vessel. For the inner basin used in Gautier's apparatus he has substituted a plate of such diameter as to leave a space of 5 millimeters between its edge and the side of the outer vessel, and the plate being carefully levelled, it is possible to flow over it a mere film of mercury, which will give sharp images under most adverse circumstances.

It may not be out of place here to call attention to the suggestion made by Brashear and others in regard to standard dimensions in astronomical and physical instruments. The great convenience which would result from having the fittings of telescopes, eye pieces, draw tubes, etc., interchangeable can hardly be over-estimated.

MISCELLANEOUS.

The Lalande prize of the Paris Academy in 1887 was awarded to Dr. Dunér, of the Lund Observatory, Sweden, for his double-star work and his researches on stellar spectra; the Valz prize to Périgaud for his valuable investigations of the meridian instruments of the Paris Observatory and other important astronomical work. The Janssen prize for progress in astronomical physics, awarded this year for the first time, was decreed to the late Dr. Kirchhoff; the Arago medal, also awarded for the first time, to Bischoffsheim the founder of the Nice Observatory; and the La Caze physical prize to Paul and Prosper Henry for their work in astronomical photography. The Rumford medal of the Royal Society was presented to Professor Tacchini, for his investigations on the physics of the sun, November 30, 1888.

In 1888 the Lalande prize was awarded to Bossert for his extensive and valuable astronomical computations; the Valz prize, to Prof. E. C. Pickering for photometric work; the Janssen prize, to Dr. Huggins for his researches in spectrum analysis. The Damoiseau prize was not awarded.

The gold medal of the Royal Astronomical Society was awarded on February 10, 1888, to Dr. Auwers, for his re-reduction of Bradley's observations. The Draper medal of the National Academy of Sciences was awarded in April to Professor Pickering, and the Lawrence Smith medal, to Professor Newton for his original work on the subject of meteorites.

Prizes amounting in value to about $1,000 were distributed at the December, 1887, meeting of the French Astronomical Society for the best schemes submitted for reforming the calendar. The chief prize was secured by M. Gaston Armelin, of Paris.

Telegraphic transmission of astronomical data.—Early in 1888 a new code book, "The Science Observer Code," for the convenient and accurate transmission of astronomical data by telegraph, was published by Messrs. Chandler and Ritchie as "Occasional Publications No. 1" of the Boston Scientific Society. The new code book supersedes the dictionary formerly in use, and as the words are conveniently numbered it is used with great facility. The number code of 200 quarto pages is followed by a phrase code with numerous examples, covering 17 pages, and by tables for reducing decimals of a day to hours, minutes, and seconds, and *vice versa.*

The number words have been selected from the dictionaries of several languages, it being the intention that the literal arrangement of any word should differ from that of every other by at least two letters; all words of more than ten letters are excluded. The words are arranged in 400 sections, numbered from 0 to 399, each section comprising 100 words, numbered from 0 to 99; any integral number up to 39,999 can therefore be represented by a single letter. The phrase code is arranged for the transmission of information in regard to comets, planets, variable stars, the state of the weather, and for reference, also, to stars in the Durchmusterung and Gould's zone catalogue. Checks are provided for correcting errors which have been introduced in the transmission. After the lapse of sufficient time for all astronomers so desiring to provide themselves with a copy of the code, it finally went into effect on October 1, 1888. The observatory of Harvard College is the central station for the distribution of astronomical information in this country, and Dr. Krueger, at Kiel, serves in a like capacity for Europe.

A paper in No. 2791 of the Astronomische Nachrichten, on the meteorological conditions favorable for establishing a large telescope, should command the attention of any one upon whom may rest the responsibility of locating a new observatory. It is manifestly important that a careful examination of the meteorological conditions of any proposed site for a large telescope should be made, particularly with reference to the quality of the images of the stars. This can be done with a scintilloscope or more accurately with the scintillometer, for it is this scintillation or superposition of an infinite number of movable images that causes the unsatisfactory seeing so often encountered. Herr Exner, in studying the scintillation at Vienna, has not found a single night on which this disagreeable phenomenon was not present.

"The Observatory" on completing its tenth volume with the number for December, 1887, passed from the hands of Messrs. Maunder, Downing and Lewis to Messrs. Turner and Common. The editors' address remains Hyde House, Westcombe Park, Blackheath, S. E., England.

The twefth meeting of the International Astronomische Gesellschaft was held at Kiel from the 29th to the 31st of August, 1887, under the presidency of Dr. Auwers. The next meeting will be at Brussels in 1889.

A new society for encouraging the study of nature, the "Gesellschaft Urania," has been established at Berlin under the presidency of Professor Förster, of the Berlin observatory. Popular lectures are given on scientific subjects, and a very well written popular journal, "Himmel und Erde," is published, especial attention being paid to astronomy.

Another new society, the "Société Astronomique de France," founded January 28, 1887, at Paris, by M. Flammarion, has met with remarkable success. Reports are published in the "Observatory," and in "L'Astronomie," and the proceedings appear in an annual bulletin.

Among recent works of general interest to astronomers are Professor Langley's "New Astronomy," Young's "Text-book on Astronomy," Proctor's "Old and New Astronomy," which is being published in parts, and volume I, part 1, of Houzeau and Lancaster's admirable "Bibliographie générale de l'astronomie."

ASTRONOMICAL BIBLIOGRAPHY FOR 1888.

The following list contains the titles of the most important books and journal articles published during the year 1888, with a few papers of earlier date, that have come under the writer's notice. A number of titles have also been taken from reviews or catalogues where the publications themselves have not been accessible. A more complete bibliography for the year 1887 has already been published in the Smithsonian Miscellaneous Collections, No. 664, and it has not seemed advisable to extend the present list by including references to observations of comets and asteroids, or the titles of journals or other annual publications. The prices quoted are generally from Friedländer's Naturæ Novitates, in German "marks" (1 mark=100 pfennige=1 franc 25 centimes=25 cents, nearly).

In the references to periodicals the volume and page are simply separated by a colon; thus: "Astron. Nachr., 118 : 369," indicates volume

118, page (or column) 369. Among imprint and other abbreviations there occur:

Abstr.= Abstract.
Am.= American.
Bd.= Band.
d.= die, der, del, etc.
ed.= edition.
Hft.= Heft.
hrsg.= herausgegeben.
il.= illustrated.
j., jour.= journal.
k. k.= kaiserlich könliigch.
Lfg.= Lieferung.
M.= marks.
n. d.= no date.
n. p.= no place of publication.
n. F.= neue Folge.
n. s.= new series.
Not.= notices.
obsrvs.= observations.
Obsry.= Observatory.
p.= page.
pl.= plates.
portr.= portrait.
pt.= part.
r.= reale.
Rev.= review.
s.= series.
sc.= science, scientific.
sup.= supplement.
v., vol.= volume.

Aberration.

BATTERMANN (H.) Einige Berichtungen aus dem Gebiete der Aberration und Fortpflanzungsgeschwindigkeit des Lichts. Astron. Nachr., 118: 369.

NYRÉN (M.) Aberration der Fixsterne. Mél. math. astron. Acad. imp. de St.-Pétersb., 6: 653-667.

Aberration (Constant of).

BATTERMANN (H.) Erwiderung auf das Schreiben von Herrn Folie. Astron. Nachr., 119: 297.

COMSTOCK (G. C.) Examination of some errors possibly affecting measures of distance made with the prism apparatus of M. Loewy. Astron. Jour., 8: 17-21.

FOLIE (F.) Schreiben . . . betr. die Aberrationsconstante. Astron. Nachr., 119: 185.

HALL (A.) [Value of the constant of aberration deduced from Washington prime vertical observations, 1862-'67.] Astron. Jour., 8: 1-5, 9-13.

KÜSTNER (F.) Neue Methode zur Bestimmung der Aberrationsconstante, nebst Untersuchungen über die Veränderlichkeit der Polhöhe. 59 p. 4to. Berlin, 1888 .... (M. 3)

Beob.-Ergeb. d. k. Strnwrt. zu Berl., Heft 3.

Altazimuth.

SCHUR (W.) Untersuchungen und Beobachtungen am Altazimuth der Strassburger Sternwarte. Astron. Nachr., 120: 1-30.

American Astronomical Society.

PAPERS . . . No. 3. 85 p. 8vo. Brooklyn, 1888.

Asteroid 11.

LUTHER (R.) Berechnung des Planeten 11, Parthenope. Astron. Nachr., 118: 301-304.

Asteroid 111.

HOLETSCHEK (J.) Ueber die Bahn des Planeten 111, Ate. Theil 3. 31 p. 8vo. Wien, 1888.

Asteroid 114.

ANTON (F.) Specielle Störungen und Ephemeriden . . . 38 p. 8vo. Wien, 1888 .... (M. 0.60)

Asteroid 139.

COMSTOCK (G. C.) Historical note relative to the name of the planet Juewa. Sid. Mess., 7: 214.

Asteroid 154.

ANTON (F.) Specielle Störungen und Ephemeriden . . . 38 p. 8vo. Wien, 1888 .... (M. 0.60)

Asteroid 183.

DONNER (A.) Bahn des Planeten 183, Istria. Astron. Nachr., 119: 37–40.

LUTHER (W.) Bahnbestimmung des Planeten 183, Istria. Astron. Nachr., 118: 365.

Asteroids.

BERBERICH (A.) Versuch die Gesammtmasse und Anzahl der Planetoiden zwischen Mars und Jupiter zu ermitteln. Astron. Nachr., 118: 289–296.

MONCK (W. H. S.) Companion asteroids. Sid. Mess., 7: 334.

PARKHURST (H. M.) Photometric observations of asteroids. Ann. Harv. Coll. Obsry., 18: 29–72 (v. 18, pt. 3). *Also*, Reprint.

PARMENTIER (*Gen.*) Distribution des petites planètes dans l'espace. il. L'Astron., 7: 226–231.

Asteroids of 1887.

LEHMANN (P.) Zusammenstellung der Planeten-Entdeckungen im Jahre 1887. Vrtljschr. d. astron. Gesellsch., 23: 8–12.

Astronomy.

NEWCOMB (S.) Place of astronomy among the sciences. Sid. Mess., 7: 14–20, 65–73. *Also, transl.:* Ciel et Terre, 9: 145–157. *Also, transl.:* Rev. d. obsrio., 3: 105, 120.

Astronomy (Bibliography of).

WINLOCK (W. C.) Bibliography of astronomy for the year 1887. 63 p. 8vo. Washington, 1888.

Smithson. Miscel. Coll., 664.

Astronomy (Descriptive).

BERNEIKE (M. L.) Astronomy note book. 36 p. 8vo. New York, 1888..(M. 2.50)

EMMERICH (A.) Unser nächtlicher Sternenhimmel. 12 + 74 p. il. 8vo. Bamberg, 1888..(M. 2)

GORE (J. E.) Planetary and stellar studies. 264 p. il. 12mo. London, 1888.

JEANS (H. W.) Hand-book for the stars; containing rules for finding the names and positions of all the stars of the first and second magnitudes. 4. ed., revised by W. R. Martin. 4to. 3 maps. London, 1888.....................(M. 5.30)

PROCTOR (R. A.) Old and new Astronomy. Pts. 1—7. 448 p. 4to. London, 1888.

In twelve parts. Each part 2*s*. 6*d*.

QUEKETT CLUB MAN (*pseud.*) My telescope and some objects which it shows me. 84 p. 12mo. London, 1888.................................(M. 2.70)

SERVISS (G. P.) Astronomy with an opera glass . . . New York, 1888..(M. 7.80)

Astronomy (History of). *See, also,* ASTRONOMY (Progress of).

CLERKE (A. M.) Geschichte der Astronomie während des neunzehnten Jahrhunderts gemeinfasslich dargestellt. Autorisierte deutsche Ausgabe von H. Maser. 15 + 540 p. 8vo. Berlin, 1889 [1888]........................(M. 10)

DETAILLE (C.) L'astronomie des anciens Égyptiens. il. L'Astron., 7: 339–347.

Astronomy (Progress of).

FLAMMARION (C.) Les progrès de l'astronomie pendant l'année 1887. L'Astron., 7: 161–173.

[HARKNESS (W.)] Astronomical progress and phenomena [1887]. Appleton's Ann. Cycl., 27 (n. s., 12); 35–45.

KLEIN (H. J.) Fortschritte der Astronomie. Nr. 13, 1887. 139 p. 12mo. Leipzig, 1888...(M. 2)

Repr. from: Rev. d. Naturwissensch., Nr. 76.

SAFFORD (T. H.) Development of astronomy in the United States: a discourse read June 25, 1888, to commemorate the fiftieth anniversary of the Hopkins Observatory of Williams College. 32 p. 8vo, Williamstown, 1888. *Also:* Sid. Mess., 7: 430.

Astronomy (Spherical and Practical).

CASPARI (E.) Cours d'astronomie pratique . . . Partie 1. 12 + 287 p. il. 8vo. Paris, 1888 .... (M. 7.80)

WEISS (E.) Anweisung zur Beobachtung allgemeiner Phänomene am Himmel mit freiem Auge oder mittelst solcher Instrumente wie sie dem Reisenden zur Verfügung stehen. *In:* Anleitung zu wissensch. Beob. auf Reisen . . . von G. Neumayer, 1: 359-402.

Berlin Observatory.

MARCUSE (A.) Untersuchung der grossen Schraube am Bamberg'schen Mikrometerapparat . . . Astron. Nachr., 119: 247.

Calendar.

ARMELIN (G.) [Projet de la] réforme du calendrier. L'Astron., 7: 347.

——. La réforme du calendrier. Ciel et Terre, 9: 318-328.

RAAB (D. L.) Universalkalender für die julianische, gregorianische, jüdische, jüdisch-julianische und jüdisch-gregorianische Zeitrechnung. 8 + 649 p. 4to. Budapest, 1887.

Carleton College Observatory.

[DESCRIPTION of the building and instruments.] Sid. Mess., 7: 321-325.

Christiania Observatory.

GEELMUYDEN (H.) Christiania Observatoriums Polhöide bestemt ved Observationer i förste Vertical. 50 p. 8vo. Christiania, 1888 .... (M. 1.30)

Chronology.

MAHLER (E.) Chronologische Vergleichungstabellen, nebst einer Anleitung zu den Grundzügen der Chronologie. 1. Heft. Wien, 1888.

Chronometers.

HILFIKER (J.) Einfluss des Luftdruckes auf den Gang von Marinechronometern. Astron. Nachr., 120: 109.

Clocks.

CORNU (A.) Sur une objection faite à l'emploi d'amortisseurs électro-magnétiques dans les appareils de synchronisation. Compt. Rend., 106: 26-31.

——. Réglage du courant électrique donnant à l'oscillation synchronisée une amplitude déterminée. il. Compt. Rend., 106: 96-100.

——. Réglage de l'amortissement et de la phase d'une oscillation synchronisée réduisant au minimum l'influence des actions perturbatrices. Compt. Rend., 106: 1206-1213.

DEFFORGES (—.) Sur un point de l'histoire du pendule. Compt. Rend., 106: 1657-1660.

DOBERCK (W.) Rate of the Hong-Kong standard clock. Astron. Nachr., 120: 183.

FÖRSTER (W.) Untersuchungen über Pendel-Uhren. *In his:* Studien zur Astrometrie, 115-150.

GERLAND (E.) Die Erfindung der Pendeluhr. Ztschr. f. Instrmknd., 8: 77-83.

KEELER (J. E.) Experiments with electrical contact apparatus for astronomical clocks. Sid. Mess., 7: 9-14.

WOLF (C.) Remarques sur la dernière note de M. Cornu relative à la synchronisation des pendules. Compt. Rend., 106: 31, 93.

ZWINK (M.) Pendeluhren im luftdicht verschlossenen Raume mit besonderer Anwendung auf die bezüglichen Einrichtungen der Berliner Sternwarte. 32 p. 4to. Kiel, 1888 .... (M. 1.80)

Code (Astronomical).

ANNOUNCEMENT as to the new Science Observer code. Astron. Jour., 8: 102.

[CHANDLER (S. C.), jr., and RITCHIE (J.), jr.] Science observer code. [400] + 17 + p. 4to. Boston, 1888 .... ($5.00)

Boston Scientific Soc. Occasional publns., No. 1.

Code (Astronomical)—Continued.

KRÜGER (A.) Angelegenheiten der Centralstelle für astronomische Telegramme. Astron. Nachr., 119: 17–22.

—— [Number of subscribers to astronomical telegrams.] Month. Not., 48: 352.

RITCHIE (J.) Announcement with reference to the astronomical code. Astron. Jour., 7: 189.

Cointe Observatory.

UBAGHS (P.) Notice sur l'observatoire de Cointe. 14 p. 8vo. Liège, 1888 ....(M. 0.80)

Repr. from: Mém. Soc. d. sc., Liège.

Collimators.

CORNU (A.) Sur l'emploi du collimateur à réflexion de Fizeau comme mire lointaine. Compt. Rend., 107: 708–713.

Colored stars.

FRANKS (W. S.) Introduction to a catalogue of the mean colors of 758 stars; with appendix containing the colors of 26 southern stars. Month. Not., 48: 265–267.

SCHRÖDER (H. C.) Chambers' neues Verzeichniss von roten Sternen. Sirius, 20: 223, 256, 279; 21: 7, 63, 78, 106, 127.

Comet Encke.

BERBERICH (A.) Helligkeit des Encke'schen Cometen. Astron. Nachr., 119. 49–66. *Also:* Sirius, 21: 151.

SHERMAN (O. T.) A study in the elements of Encke's comet. Astron. Jour., 8: 99.

Comet Tempel.

GAUTIER (R.) Étude consacrée spécialement aux apparitions de 1873 et de 1879. 4 + 110 p. 4to. Genève, 1888 ....(M. 4.50)

Comet Winnecke.

VON HAERDTL (E.) Bahn des periodischen Cometen Winnecke in den Jahren 1858–1886, nebst einer neuen Bestimmung der Jupitermasse. Anzeig. Wien. Akad., 1888, Nr. 18..(M. 4.80)

Comet 1666.

LYNN (W. T.) [Account of the comet in February, 1666, by Robert Knox.] Obsry., 11: 375.

Comet 1680.

LYNN (W. T.) First discovery of the great comet of 1680. Obsry., 11: 437.

Comet 1833.

SCHULHOF (L.) Orbites des deux comètes de 1833 et 1883. Bull. astron., 5: 248, 480, 532.

Comet 1862 II.

CERULLI (V.) Sull' orbita della cometa del Luglio 1862. Astron. Nachr., 118: 193–204.

Comet 1863 III.

ERICSSON (G.) Definitive Bahnelemente des Cometen 1863 III. Astron. Nachr., 118: 353–360 ....(M. 1.30)

Comet 1873 II.

SCHULHOF (L.) Éléments et éphéméride de la comète 1873 II (Tempel). Bull. astron., 5: 425. *Also:* Astron. Nachr., 120: 173.

Comet 1879 IV.

MILLOSEVICH (E.) Orbita della comèta 1879 IV. Mem. Soc. spettrscp. ital., 17: 55.

Comet 1882 II.

KREUTZ (H.) Untersuchungen über das Cometensystem 1843 I, 1880 I und 1882 II. I. Theil. Der grosse September comet 1882 II. 110 p. 4to. Kiel, 1888.
Publ. d. Strnwrt. in Kiel.

Comet 1885 III.

CAMPBELL (W. W.) Definitive determination of the orbit of comet 1885 III. Astron. Nachr., 120: 49–58.

Comet 1887 IV.

MULLER (F.) Definitive determination of the orbit of comet 1887 IV. Astron. Jour., 8: 44–56, 71.

Comet seeker.

HILL (G. A.) [Altazimuth mounting of 6¼-inch reflector.] il. Sid. Mess., 7: 241.

Comets.

BACKHOUSE (T. W.) Naked-eye comets. Obsry., 11: 333.

BERBERICH (A.) [Method and desirability of photometric observations of comets.] Astron. Nachr., 119: 66.

FAYE (H.) Hypothèse de Lagrange sur l'origine des comète set des aérolithes. Compt. Rend., 106: 1703–1708. *Also:* Ciel et Terre, 9: 237–243.

HALL (A.) Problem of alignment. Astron. Jour., 8: 143.

HOLETSCHEK (J.) Richtungen der grossen Axen der Cometenbahnen. *Abstr.:* Astron. Nachr., 120: 137.

KIAER (H. J.) Équations servant à déterminer les formes des queues cométaires. Astron. Nachr., 119: 369–378; 120: 107.

MONCK (W. H. S.) Cometary statistics. Obsry., 11: 432.

—— Dissipation of comets. Sid. Mess., 7: 239.

TEBBUTT (J.) Comet nomenclature. Obsry., 11: 436.

Comets and meteors.

KIRKWOOD (D.) Relation of short-period comets to the zone of asteroids. Sid. Mess., 7: 177–181.

Comets of 1887.

KREUTZ (H.) Zusammenstellung der Cometen-Erscheinungen des Jahres 1887. Vrtljschr. d. astron. Gesellsch., 23: 13–20.

WILSON (H. C.) [Account of the comets of 1887, with elements and references to observations.] Sid. Mess., 7: 153–160. *Also,* Reprint.

Comets (Orbits of).

LOHNSTEIN (T.) Ermittelung der geocentrischen Distanzen eines Cometen. Astron. Nachr., 119: 99–106.

Constellations.

PLOIX (C.) [Légendes de] la grande ourse. Ciel et Terre, 9: 25–37.

Corona (Solar).

NEUE Hypothese über die Natur der Sonnen-Korona. Sirius, 21: 1.

WESLEY (W. H.) Corona of 1886. il. Obsry., 11: 357–360.

Cosmogony. *See, also,* NEBULÆ; NEBULAR HYPOTHESIS; METEORITES.

JANSSEN (J.) L'âge des étoiles. Ciel et Terre, 9: 449, 465. *Also:* L'Astron., 7: 19, 59. *Also, transl.:* Sirius, 21: 49–57.

Dearborn Observatory.

HOUGH (G. W.) [Removal to new site.] Astron. Nachr., 119: 207.

JOHNSON (H. A.) [Address at the laying of the corner-stone of the new building, June 24, 1888.] Sid. Mess., 7: 381–385.

TENNANT (J. F.) [Position and constants for the new observatory.] Month. Not., 49: 95.

Domes.

CROSSLEY (E.) Description of a new observatory for a 3-foot reflector. 1 pl. Month. Not., 48: 356–359.

Double stars.

BURNHAM (S. W.) New double stars discovered at the Lick Observatory. Astron. Jour., 8: 141.

CLERKE (A. M.) Historical and descriptive list of some double stars suspected to vary in light. Nature, 39: 55–58.

—— Variable double stars. Obsry., 11: 188.

FLAMMARION (C.) Nouveaux systèmes stellaires. L'Astron., 7: 66.

MONCK (W. H. S.) Brightness and density of binary stars. Obsry., 11: 341.

—— Distances of double stars. Sid. Mess., 7: 290.

SCHIAPARELLI (G. V.) Osservazioni sulle stelle doppie Serie 1 . . 1875–1885, 85+144 p. 4to. Milano, 1888.......................................(M. 7)

Earth.

BISCHOFF (J.) Neue Beziehungen auf dem Geoid. Astron. Nachr., 119: 177–184.

BONNEY (T. G.) Foundation-stones of the earth's crust. Nature, 39: 89–94.

CALLANDREAU (O.) Remarques sur la théorie de la figure de la terre. Bull. Astron., 5: 473–480.

HAYWOOD (J.) The earth and its chief motions, and the tangent index. 28 p. 12mo. Dayton, 1888..(M. 0.80)

HELMERT (F. R.) Mittheilung über eine beabsichtigte Cooperation mehrerer deutscher Sternwarten in Bezug auf die Untersuchung kleiner Bewegungen der Erdaxe. Astron. Nachr., 120: 225–230.

HILL (G. W.) Interior constitution of the earth as respects density. Ann. Math. 4: 19–29. *Also*, Reprint.

LÉVY (M.) Théorie de la figure de la terre. Compt. Rend., 106: 1270–1276, 1314–1320, 1375–1381.

POINCARÉ (H.) Sur la figure de la terre. Compt. Rend., 107: 67–71.

RICCÒ (A.) Immagine del sole riflessa nel mare prova della rotondità della terra. il. Mem. Soc. spettrscp. ital., 17: 203–220.

Eclipse of Thales.

PETERS (C. F. W.) Sonnenfinsterniss des Thales. Astron. Nachr., 120: 231.

Eclipse of the Moon, 1888, Jan. 28.

BÖDDICKER (O.) Veränderungen der Wärmestrahlung des Mondes während der totalen Mondfinsterniss 1888, Jan. 28. 1 pl. Astron. Nachr., 118: 310. *See, also:* Nature, 37: 318.

Eclipse of the Sun, 1886, Aug. 28–29.

TURNER (H. H.) Report of the observations . . . made at Grenville, in the Island of Grenada. 2 pl. Mem. Soc. spettrscp. ital., 17: 46.

Eclipse of the Sun, 1887, Aug. 18.

HARKNESS (W.) [Résumé of observations.] Sid. Mess., 7: 1–8.

NIESTEN (L.) L'éclipse totale de soleil du 19 août 1887, observée à Jurjewetz, Russie. 21 p. 12mo. Bruxelles, 1888.

Repr. from: Ann. de l'obs. roy. de Bruxelles, 1889.

TODD (D. P.) Preliminary report . . . 16 p. 8vo. Amherst, 1888.

UPTON (W.) and ROTCH (A. L.) Meteorological observations . . . 25 p. 8vo. Ann Arbor, 1888.

Repr. from: Am. Meteorol. J., 1888.

VOGEL (H. C.) [Instructions for observing the eclipse.] Vrtljschr. d. astron. Gesellsch., 23: 130–135.

Eclipse of the Sun, 1889, Jan. 1.

HOLDEN (E. S.) Suggestions for observing the total eclipse of the Sun on Jan. 1, 1889. 21 p., 1 map. 8vo. Sacramento, 1888.

Eclipse of the Sun, 1889, Jan. 1—Continued.

—— [Probable meteorological conditions at that time.] Month. Not., 48: 302–307.

Todd (D. P.) Instructions for observing the total eclipse of the Sun, 1889, Jan. 1. il. 16 p. 8vo. Amherst, 1888 ....(M. 1.20)

Eclipses.

Flammarion (C.) Éclipses [de soleil] du 19e siècle visibles en France ou aux environs. L'Astron., 7: 306–311.

Ginzel (F. K.) Finsterniss Canon für das Untersuchungsgebiet der römischen Chronologie. 36 p. 8vo. Berlin Akad., 1887 ....(M. 1.50)

Lynn (W. T.) Earliest recorded eclipse. Obsry., 11: 197.

Mahler (E.) Astronomische Untersuchungen über die angebliche Finsterniss unter Thakelath II. von Aegypten. 14 p. 4to. Wien, 1888 ....(M. 0.80)

Eclipses of the moon.

Bruns (H.) Heliometermessungen bei Mondfinsternissen. Astron. Nachr., 118: 363.

Johnson (S. J.) Earliest recorded lunar eclipse. Obsry., 11: 340.

Lynn (W. T.) Earliest recorded lunar eclipse. Obsry., 11: 376.

Edinburgh Observatory.

Smyth (C. Piazzi). Report on the Royal Observatory, Edinburgh, for 30 June, 1888, and the Edinburgh equatorial in 1887. 16 p. 4to. [n. p., 1888.]

Electric light.

Bruns (H.) [Electric illumination of the Leipzig heliometer.] Vrtljschr. d. astron. Gesellsch., 23: 109.

Spitta (E. J.) Simple electric light for the telescope. il. Obsry., 11: 368.

Engelmann (Friedrich Wilhelm Rudolf). [1841–1888.]

Bruns (H.) Todes-Anzeige. Astron. Nachr., 119: 47.

Peter (B.) Nekrolog. Vrtljschr. d. astron. Gesellsch., 23: 153–157.

Equatorial coudé.

Loewy (M.) and Puiseux (P.) Théorie nouvelle de l'equatorial coudé et des équatoriaux en général. (Exposé de l'ensemble des méthodes permettant de rectifier et d'orienter ces instruments.) Compt. Rend., 106: 704–711, 793–800, 891–898, 970–976, 1199–1206, 1320–1326, 1483–1489.

Equatorials. *See, also,* Telescopes.

Förster (W.) Untersuchungen über das Fraunhofer'sche Aequatorial. *In his:* Studien zur Astrometrie, 160–206.

Grubb (H.) New arrangement of electrical control for driving clocks of equatorials. Month. Not., 48: 352–356.

Ranyard (A. C.) Simple method of applying electrical control to the driving clock of an equatorial. il. Month. Not., 48: 336.

Eudoxus.

Lynn (W. T.) Narrien and the observations of Eudoxus of Cnidus. Obsry., 11: 300.

Flexure.

Bauschinger (J.) Biegung von Meridianfernröhren. 18 p., 1 pl. 4to. München, 1888 ....(M. 2)

Strehl (K.) Beugung im Fernrohr. Sirius, 21: 132–138.

Galileo.

Lynn (W. T.) Galileo Galilei and his condemnation. Obsry., 11; 314–317.

Geographical positions.

Stadthagen (H.) Beiträge zur Untersuchung des Genauigkeitsgrades astronomischer Berechnungen mit Anwendung auf eine in der geographischen Ortsbestimmung häufig vorkommende Aufgabe. 84 p. 8°. Berlin, 1888 .....(M. 2.)

Tietjen (F.) Geographische Ortsbestimmung. *In:* Anleitung zu wissensch Beob. auf. Reisen . . . von G. Neumayer, 1: 1–40.

Gravitation.

CALLANDREAU (O.) Énergie potentielle de la gravitation d'une planète. Compt. Rend., 107: 555.

HALL (A.) The extension of the law of gravitation to stellar systems. Astron. Jour., 8: 65–68.

Greenwich Observatory.

ASTRONOMICAL and magnetical and meteorological observations . . . 1886 [1027+] p. 4to. London, 1888.

Harvard College Observatory.

ANNALS . . . vol. 13, pt. 2. Zone observations made with the transit wedge photometer . . . 149 p. 4to. Cambridge, 1888.

ANNALS . . . vol. 18, pt. 3. Photometric observations of asteroids. 44 p. 4to. Cambridge, 1888.

DRAPER (Henry) memorial. Second annual report of the photographic study of stellar spectra . . . [by] E. C. Pickering. 8 p. 2 pl. 4to. Cambridge, Mass., 1888.

REPORT (43d annual) of the director . . . E. C. Pickering . . . Dec. 15, 1888. 11 p. 8vo. Cambridge, 1888.

Houzeau (Jean Charles). [1820–1888.]

L[ANCASTER] (A.) Notes biographiques. Ciel et Terre, 9, 313, 361, 385, 409, 457, 481.

See, also, Ibid. 249–270. *Also:* Obsry., 11: 318–320.

Instruments (Astronomical). *See, also,* ALTAZIMUTH; EQUATORIALS; LEVELS, etc.

BRASHEAR (J. A.) Standard dimensions in astronomical and physical instruments. Proc. Am. Assn. Adv. Sc., 36: 61. *Also,* Sid. Mess., 7: 77.

Jena Observatory.

WINKLER (W.) Verlegung seiner Privatsternwarte nach Jena . . . Astron. Nachr., 118: 205.

Journals (Astronomical).

HIMMEL und Erde. Illustrirte naturwissenschaftliche Monatschrift. Hrsg. von der Gesellschaft Urania. Redacteur; M. Wilhelm Meyer.

1. Jahrgang, Heft 1. October, 1888. Preis vierteljährlich. M. 3.60; einzelne Hefte..(M.2)

Jupiter.

DENNING (W. F.) Rotation of Jupiter. Obsry., 11: 88.

——. Motion of the red spot on Jupiter. Obsry., 11: 406.

LYNN (W. T.) Rotation of Jupiter. Obsry., 11: 125.

SCHULTZ-STEINHEIL (C. A.) [Werth für den Halbmesser des Planeten.] Astron. Nachr., 119: 129–138.

Jupiter (Satellites of).

ANDRÉ (C.) Ligament lumineux des passages et occultations des satellites. Compt. Rend., 107: 216.

——. Ligament lumineux des passages et occultations des satellites de Jupiter. Moyen de l'éviter. Compt. Rend., 107: 615.

Kepler's problem.

SEYDLER (A.) Zur Lösung des Kepler'schen Problems. Astron. Nachr., 118: 261–271.

Kew Observatory.

REPORT of the Kew committee for the year ending October 31, 1888. 28 p. 8vo. London, 1888.

Levels.

MYLIUS (F.) Störungen der Libellen. Ztschr. f. Instrmknd., 8: 267–283, 428.

Lick Observatory.

[Description of buildings and instruments.] il. Engineering, 46: 1, 81, 149, 151, 396.

[Histoire de] l'observatoire Lick. il. Ciel et Terre, 9: 105–112.

Holden (E. S.) [Description of] the Lick Observatory. il. Sid. Mess., 7: 49–65.

——. [First astronomical observations, etc.] Nature, 38: 355.

——. [Formal transfer to the University of California.] Astron. Jour., 8: 43.

——. Hand-book of the Lick Observatory of the University of California. 135 p. 16°. il. San Francisco, 1888.

Neues Spektroskop des Lick-Observatoriums und die photographische Beobachtung der Sternenspektren. Sirius, 21: 230.

Light.

Bell (L.) Absolute wave-length of light. Am. J. Sc., 135: 265–282, 348–368.

Longitude. *See, also,* Geographical positions.

Caspari (—.) Formule pour le calcul des longitudes par les chronomètres. Compt. Rend., 107: 78.

Lunar theory.

Adams (J. C.) Remarks on Airy's numerical lunar theory. Month. Not., 48: 319–322.

Airy (G. B.) The numerical lunar theory. Month. Not., 48: 253; 49: 2.

Franz (J.) Neue Berechnung von Hartwig's Beobachtungen der physischen Libration des Mondes. 8 p. 4to. Berlin, 1887 ....(M. 0.30)

Harzer (P.) Apsidenbewegung der Mondbahn. Astron. Nachr., 118: 273–280.

Oppolzer (T.) and Schram (R.) Entwurf einer Mondtheorie gehörende Entwicklung der Differentialquotienten . . . 188 p. 4to. Wien. 1888 ....(M. 10)

Repr. from: Denkschr. d. k. Akad. d. Wissensch. Math. naturw. Cl. Wien. 54: 59–244.

Tisserand (F.) Sur un point de la théorie de la lune. Compt. Rend., 106: 788–793.

Lyons Observatory.

André (C.) Travaux de l'observatoire de Lyon. Partie 1. Influence de l'altitude sur la marche diurne du baromètre. 153 p., 5 pl. 4to. Lyon, 1888.

McCormick Observatory.

Report . . . for the year ending June 1, 1888. 3 p. 8vo. [n. p., n. d.]

Madras Observatory.

Results of observations of the fixed stars made with the meridian circle at . . . Madras in the years 1862, 1863, and 1864, under the direction of N. R. Pogson. 47+314 p. 4to. Madras, 1887.

——. Same. 1865, 1866, 1867. 22+362 p. 4 to. Madras, 1888.

Mars.

Erklärung der Kanäle. Sirius, 21: 227–230.

Faye (H.) [Les canaux et la région Libya.] Comp. Rend., 106: 1718.

Fizeau (H. L.) Les canaux . . . Compt. Rend., 106: 1759–1762.

F[lammarion] (C.) Inondations de la planète Mars: variations observées dans les canaux, les lacs et les mers. il. L'Astron, 7: 241–253.

——. Nouvelles observations sur la planète Mars: ses neiges, ses eaux et ses climats. il. L'Astron. 7: 281–291.

——. Un dernier mot sur la planète Mars. il. L'Astron., 7: 412–422.

——. Fleuves de la planète Mars. il. L'Astron., 7: 457–462.

——. Les neiges, les glaces et les eaux de la planète Mars. Compt. Rend., 107: 19–22.

Hall (A.) Appearance of Mars, June, 1888. Astron. Jour., 8: 79.

Holden (E. S.) Physical observations of Mars during the opposition of 1888, at the Lick Observatory. Astron. Jour., 8: 97.

Maunder (E. W.) Canals on Mars. Obsry., 11: 345–348.

Mars—Continued.

NIESTEN (L.) Sur l'aspect physique de la planète Mars, pendant l'opposition de 1888. 12 p. 1 pl. 8vo. Bruxelles, 1888.
Bull. de l'Acad. roy. de Belg., 3 s., vol. 16, No. 7.

PERROTIN (J.) Canaux de Mars. Nouveaux changements observés sur cette planète. il. L'Astron., 7: 213.

——. Nouvelles observations sur la planète Mars. il. L'Astron., 7: 366–370.

——. Observation des canaux de Mars. Compt. Rend., 106: 1393.

——. [Croquis de Mars.] Compt. Rend., 107: 161, 496.

PICKERING (W. H.) Physical aspect of the planet Mars. Science, 12: 82.

PROCTOR (R. A.) Note on [the canals of] Mars. Month. Not., 48: 307.

TERBY (F.) [Dessins de] la planète Mars. il. L'Astron., 7: 324.

——. Les canaux de Mars, leur gémination et les observations de 1888. il. Ciel et Terre, 9: 271–286, 289–302.

——. Premières observations de Mars et de Saturne faites à l'observatoire Lick . . . en 1888, et réponses à quelques objections. Ciel et Terre, 9: 370–380.

——. Étude de la planète Mars. Compt. Rend., 106: 1470.

——. [Vérification des cartes de Schiaparelli.] Obsry., 11: 298.

WISLICENUS (W. F.) Anwendung von Mikrometermessungen bei physischen Beobachtungen des Mars. il. Astron. Nachr., 120: 241–250.

Mars (Satellites of).

DUBOIS (E.) [Peut-être petites planètes devenues les satellites.] Compt. Rend., 107: 439.

POINCARÉ (H.) [L'hypothèse qu'ils sont de petites planètes.] Compt. Rend., 107: 890.

Maury (Matthew Fontaine) [1806–73].

CORBIN (Diana F. M.) Life of Matthew Fontaine Maury. 306 p. portr. 8vo. London, 1888.

Mechanics (Celestial).

DZIOBEK (O.) Mathematische Theorien der Planetenbewegungen. 8 + 305 p. 8vo. Leipzig, 1888 ....(M. 9)

Mercury.

SHERMAN (O. T.) A study of the residual discordances for Mercury. Astron. Jour., 8: 34–36.

Meteorites. *See, also,* METEORS.

BORNITZ (H.) Zusammenstellung der Meteoritenfälle nach Monat, Tag u. Stunde. Sirius, 21: 157–161.

DARWIN (G. H.) Mechanical conditions of a swarm of meteorites. *Abstr.:* Nature, 39: 81, 105.

DERBY (O. A.) Notas sobre meteoritos Brasilieros. Rev. d. obsrio., 3: 3, 17, 33.

HUNTINGTON (O. W.) Catalogue of all recorded meteorites . . . Proc. Am. Acad. Arts & Sc., 23: 37–110. 1887. *Also,* Reprint.

LOCKYER (J. N.) Notes on meteorites. il. Nature, 38: 424, 456, 530, 556, 602; 39: 139.

LOCKYER'S Untersuchungen über die Spektra der Meteoriten. Sirius, 21: 111–115.

NEWTON (H. A.) Orbits of aerolites. Astron. Jour., 8: 41.

——. Relation which the former orbits of those meteorites that are in our collections, and that were seen to fall, had to the earth's orbit. Am. J. Sc., 136: 1–14.

Meteors. *See, also,* COMETS AND METEORS.

BOOTH (D.) Radiant of the August Perseids. Obsry., 11: 379.

BREDICHIN (T.) Quelques remarques sur l'origine des météores. Astron. Nachr., 120: 249. *Also:* Bull. astron., 5: 521–523.

DENNING (W. F.) History of the August meteors. Nature, 38: 393.

——. The chief meteor showers. Month. Not., 48: 110.

Meteors—Continued.

Denning (W. F.) Heights of fire-balls and shooting stars. Month. Not., 48: 112.

Kleiber (J.) Vertheilung der Meteore in Meteorschwärmen. Astron. Nachr., 118: 345.

Meunier (S.) Rapports mutuels des météorites et des étoiles filantes. Compt. Rend., 107: 834.

de Tillo (A.) Recherches sur la répartition des points radiants d'après les mois de l'année et d'après les coordonnées célestes. Bull. Astron., 5: 237–248, 283–91.

Meteors (Observations of). *See, also,* Meteors.

Denning (W. F.) Height of a Perseid fire-ball. il. Month. Not., 49: 19–21.

—— Height of a Leonid fire-ball. il. Month. Not., 49: 66.

—— Leonid meteor-shower, 1888. Nature, 39: 84.

Micrometers.

Comstock (G. C.) Value of one revolution of a micrometer screw. Sid. Mess., 7: 343–409.

Kempf (P.) Ueber Lamellen-mikrometer. Astron. Nachr., 119: 33–38.

Oudemans (J. A. C.) Condition that in a double-image micrometer the value of a revolution of the micrometer screw may be independent of the accommodation of the eye. Month. Not., 48: 334.

Tupman (G. L.) On the cross reticule. il. Month. Not., 48: 96–103.

—— Description of a cross-bar micrometer. Obsry., 11: 58–61.

Mirrors.

Common (A. A.) Testing polished flat surfaces. Month. Not., 48: 105.

Madsen (H. F.) Notes on the process of polishing and figuring 18-inch glass specula by hand, and experiments with flat surfaces. Jour. and Proc. Roy. Soc. N. S. Wales, 20: 79–91, 1886.

Rev. by Common (A. A). Nature, 37: 382.

Mitchel (Ormsby Mcknight) [1809–'62].

Mitchel (F. A.) Ormsby Macknight Mitchel, astronomer and general: a biographical narrative. 8 + 392 p. portr. 12mo. Boston, 1887.

Moon. *See, also,* Lunar theory.

Elger (T. G.) Sir William Herschel's observations of volcanoes in the moon. Obsry., 11: 377.

Grensted (F. F.) Theory to account for the airless and waterless condition of the moon . . . 8vo. Liverpool, 1888.

Holden (E. S.) Sir William Herschel's observations of volcanoes in the moon. Obsry., 11: 334.

Hunt (G.) Sir William Herschel's observations of volcanoes in the moon. Obsry., 11: 403.

Thurein (—) Elementare Darstellung der Mondbahn. 4to. Berlin, 1888..(M. 1)

Williams (A. S.) Sir William Herschel's observations of volcanoes in the moon. Obsry., 11: 378.

Wolf (M.) Aufnahme von Mondphotographien. il. Sirius, 21: 97–100.

Moscow Observatory.

Annales de l'observatorie de Moscou . . . 2 s., v. 1. 2. livraison. 128 p. 6 pl. 4to. Moscow, 1888..(M. 6)

Nadir.

Périgaud (E.-L.-A.) Nouveau bain de mercure pour l'observation du nadir. Compt. Rend., 106: 919–921.

—— Observations d'étoiles par réflexion et la mesure de la flexion du cercle de Gambey. Compt. Rend., 107: 613.

Natal Observatory.

Report of the superintendent . . . 1887. 26 p. 4to. [n. p., n. d.]

Nebulæ. *See, also,* PLEIADES.

COMMON (A. A.) Photographs of nebulæ. Obsry., 11: 390–394.

DREYER (J. L. E.) New general catalogue of nebulæ and clusters of stars, being the catalogue of the late Sir John F. W. Herschel, revised, corrected, and enlarged. 237 p. 4to. London, 1888 .... (M. 21.)

Mem. Roy. Astron. Soc., v. 49, pt. 1. *Review.*—Nature, 37: 353; Astron. Nachr., 118: 367.

GINZEL (F. K.) Beobachtungen von Nebelflecken [vom Dec. 1884 bis Apr. 1886]. Astron. Nachr., 118: 321–344.

LOCKYER (J. N). Suggestions on the classification of the various species of heavenly bodies. il. Proc. Roy. Soc. 46: 1–93. *Also,* Reprint. *Also:* Nature, 37: 585, 606; 38: 8, 31, 56, 79 .... (M. 3.70)

PICKERING (E. C.) Detection of new nebulæ by photography. Ann. Harv. Coll. Obsry., 18: 113–117 (v. 18, no. 6). *Also,* Reprint.

ROBERTS (I.) Photographs of the nebulæ M, 31, *h* 44 and *h* 51 Andromedæ and M. 27 Vulpeculæ. Month. Not., 49: 65.

SWIFT (L.) Catalogue No. 7 of nebulæ discovered at the Warner Observatory. Astron. Nachr., 120: 33–38.

VOGEL (H. C.) Bedeutung der Photographie zur Beobachtung von Nebelflecken. il. Astron. Nachr., 119: 337–342.

Nebular hypothesis.

COAKLEY (G. W.) On the nebular hypothesis of La Place. 85 p. 8vo. Brooklyn, 1888.

Papers Am. Astron. Soc., No. 3.

KERZ (F.) Beitrag zur Nebular hypothese. Sirius, 20: 265; 21: 10, 34.

——. Weitere Ausbildung der Laplace'schen Nebular-hypothese. Nachtrag. 8+127 p., 3 pl. 8vo. Leipzig, 1888 .... (M. 3)

Neptune (Satellite of).

HALL (A.) [Orbit of] the satellite of Neptune. Astron. Jour., 8: 78.

NEWCOMB (S.) Note on the [orbit of the] satellite of Neptune. Astron. Jour., 8: 143.

TISSERAND (F.) [Orbite du satellite.] Compt. Rend., 107: 804–810.

Nice Observatory.

Grand équatorial de l'observatoire de Nice. il. L'Astron., 7: 447–451.

Nieuport Observatory.

DELPORTE (A.) L'observatoire astronomique temporaire de Nieuport. Ciel et Terre, 9: 423–429.

North Carolina University Observatory.

LOVE (J. L.) First college observatory in the United States. Sid. Mess., 7: 417–420; Nation, 47: 131.

Nutation.

FÖRSTER (W.) Ueber die bisherigen Annahmen in den Transformations-Elementen der astronomischen Ortsangaben. *In his:* Studien zur Astrometrie, 1–49.

NIESTEN (L.) Influence de la nutation diurne dans la discussion des observations de γ Draconis faites à l'observatoire de Greenwich. 22 p. 8vo. [Bruxelles, 1887.]

Repr. from: Mém. cour. publ. par l'Acad. roy. de Belg., 1887.

——. Influence de la nutation diurne dans la discussion des observations de α Lyræ faites à l'observatoire de Washington. 6 p. 12mo. Bruxelles, 1888.

Repr. from: Ann. de l'Obs. roy. de Brux., 1889.

Objectives.

CZAPSKI (S.) Bemerkungen zu der Abhandlung von E. v. Hoegh, "Die sphärische Abweichung . . ." Ztschr. f. Instrmknd., 8: 203–206.

GRUBB (H.) [Objectives adapted to either photographic or other work.] Nature, 37: 439.

Objectives—Continued.

HASSELBERG (B.) Méthode à déterminer avec grande exactitude les distances focales d'un système optique pour une raie quelconque du spectre. Mem. Soc. spettrscp. ital., 17: 182–188.

VON HOEGH (E.) Die sphärische Abweichung und deren Correction speciell bei Fernrohrobjectiven. Ztschr. f. Instrmknd., 8: 117.

KRÜSS (H.) Die Farben-Correction der Fernrohr-Objective von Gauss und von Fraunhofer. Ztschr. für Instrmknd., 8: 7, 53, 83.

PICKERING (E. C.) New photographic objective. Nature, 37: 558.

SCHUR (W.) Untersuchungen und Rechnungen über das Objectiv des grossen Refractors der Strassburger Sternwarte. Astron. Nachr., 119: 249–254.

VOGEL (H. C.) Ueber die Methoden zur Bestimmung der chromatischen Abweichung von Fernrohrobjectiven. Astron. Nachr., 119: 293.

WOLF (M.) Bestimmung der Farbenabweichung grosser Objective. Astron. Nachr., 120: 73.

——. Trennung der Objectivlinsen für photographische Zwecke. il. Astron. Nachr., 119: 161.

Observatories.

HOLDEN (E. S.) Principal observatories of the world. il. *In his:* Handbook Lick Obsry., 104–125.

JAHRESBERICHTE der Sternwarten für 1887. Vrtljschr. d. astron. Gesellsch. 23: 73–151.

LOVE (J. J.) [First observatory founded in the United States, at the University of North Carolina in 1831.] Nation, 47: 131.

[REPORTS of observatories, 1887.] Month. Not., 48: 175–198.

TENNANT (J. F.) Table of the positions of observatories with constants useful in correcting extra-meridian observations for parallax. Month. Not., 49: 22–32, 95.

O'Gyalla Observatory.

Beobachtungen angestellt am astrophysikalischen Observatorium in O'Gyalla, hrsg. von N. von Konkoly. 9. Bd., enthaltend Beobachtungen vom Jahre 1886. 106 p. 4to. Halle, 1888.

Orbits. *See, also,* COMETS (Orbits of); THREE BODIES (Problem of).

BRUNS (H.) Der Lambert'sche Satz. Astron. Nachr., 118: 241–250.

ISRAEL-HOLTZWART (K.) Beiträge zur Anwendung unendlicher Reihen im Gebiete der Bahnberechnung der Planeten und Kometen. 82 p. 8vo. Wiesbaden, 1888 .... (M. 2.40)

RADAU (R.) Formules pour la variation des éléments d'une orbite. Bull. astron., 5: 5–12.

SEARLE (G. M.) An improvement in the computation of an orbit. Astron. Jour., 8: 125.

Parallax (Solar).

HARKNESS (W.) Value of the solar parallax deducible from the American photographs of the last transit of Venus. Astron. Jour., 8: 108.

Parallax (Stellar).

FOLIE (F.) Détermination de la vitesse systématique et de la parallaxe des étoiles. Astron. Nachr., 119: 343.

PRITCHARD (C.) Results of recent investigations of stellar parallax made at the University Observatory, Oxford. Month. Not., 49: 2–4.

Paris Observatory.

FAYE (H.) Latitude du cercle de Gambey. Compt. Rend., 107: 810.

MOUCHEZ (E.-A.-B.) Difficulté d'obtenir la latitude de l'observatoire de Paris. Compt. Rend., 107: 848.

PÉRIGAUD (E.-L.-A.) Triple détermination de la latitude du cercle de Gambey. Compt. Rend., 107: 722.

Paris Observatory—Continued.

Rapport annual sur l'état de l'Observatoire de Paris présenté au conseil . . . 21 janvier 1888. 26 p. 1 pl. 4vo. Paris, 1888.

Pekin Observatory.

Russell (S. M.) History and description of the Pekin Observatory. Nature, 39: 46. *See, also: Ibid.*, 55.

Personal equation.

Bigourdan (G.) Variations de l'équation personnelle dans les mesures d'étoiles doubles. Compt. Rend., 106: 1645.

Hilfiker (J.) Sur l'équation personnelle dans les observations de passage. 7 p 12mo. Neuchâtel, 1888.

Repr. from: Bull. Soc. sc. nat. de Neuchâtel, vol. 16.

Renz (F.) Versuch einer Bestimmung der persönlichen Gleichung bei der Beobachtung von Sternbedeckungen. Astron. Nachr., 119: 145–150.

Sanford (E. C.) Personal equation. Am. J. Psychol., 2: 1–38, 271–298, 403–430.

Wislicenus (W. F.) Untersuchungen über den absoluten persönlichen Fehler bei Durchgangsbeobachtungen. 50 p. 1 pl. 4vo. Leipzig, 1888......(M. 3)

Perturbations.

Gaillot (A.) Théorie analytique du mouvement des planètes. Expression générale des perturbations qui sont du troisième ordre par rapport aux masses. Bull. astron., 5: 329, 377. *Also,* Reprint.

Gyldén (H.) Convergenz einer in der Störungstheorie vorkommenden Reihe. Astron. Nachr., 119: 321–330.

Harzer (P.) Differentialgleichung der Störungstheorie. Astron. Nachr., 119: 273–294.

Láska (W.) Zur Theorie der planetarischen Störungen. 5 p. 8vo. Wien, 1888...(M. 0.20)

Weiler (A.) Störungen werden als Functionen zweier Anomalien dargestellt. Astron. Nachr., 120: 97–108.

Photographic Congress, Paris, 1887.

Bulletin du comité international permanent pour l'exécution photographique de la carte du ciel. 1. et 2. fascicules, 80 p. 4to. Paris, 1888...........(M. 8)

Institut de France. Académie des Sciences.

Photography.

von Konkoly (N.) Das Hydroxylamin als Entwickler photographischer Platten. Sitzungsb. d. k. Akad. d. Wissensch. in Wien, math.-nat. Kl., 97. *Also:* Sirius, 21: 128–132.

Photography (Astronomical). *See, also,* Moon; Nebulæ.

Gill (D.) Note on some investigations of the accuracy of the Paris photographs. Obsry., 11: 292–296.

von Gothard (E.) Universalcamera für Himmelsphotographie. il. Ztschr. f. Instrmknd., 8: 41–46.

——. Erfahrungen auf dem Gebiete der Himmels- und Spektral-Photographie. Sirius, 21: 100–104.

Jesse (O.) Bestimmung von Sternschnuppenhöhen durch photographische Aufnahmen. Astron. Nachr., 119: 153.

[Review of astronomical photography.] Edinb. Rev. 145: 23–46 *Also:* Sid. Mess., 7: 138, 181.

Photography (Stellar).

Gill (D.) [Progress of the southern photographic Durchmusterung.] Astron. Nachr., 119: 257.

Holden (E. S.) Stellar photography. 4 p. 8vo [n. p., 1888].

Repr. from: Overland month.

von Kövesligethy (R.) Invisible stars of perceptible actinic power. Month. Not., 48: 114–116.

Photography (Stellar)—Continued.

[REPORT of photographic committee Royal Astronomical Society.] Month. Not., 48: 351.

ROBERTS (I.) An instrument for measuring the positions and magnitudes of stars on photographs and for engraving them upon metal plates . . . il. Month. Not., 49: 5–13.

TENNANT (J. F.) Note on the definition of reflecting telescopes and on the images of bright stars on photographic plates. Month. Not., 48: 104.

VOGEL (H. C.) Mittheilungen über die von dem astrophysikalischen Observatorium zu Potsdam übernommenen Voruntersuchungen zur Herstellung der photographischen Himmelskarte. Astron. Nachr., 119: 1–6

Photometer.

CERASKI (W.) Photomètre de Zöllner à deux oculaires. Astron. Nachr., 120: 218.

PARKHURST (H. M.) Obliteration from illumination. Sid. Mess., 7: 337–343.

Photometry. *See, also,* ASTEROIDS.

DORST (—.) Reduction der von Zöllner photometrisch bestimmten Sterne. Astron. Nachr., 118: 209–226.

MONCK (W. H. S.) [Comparison of the] Harvard and Oxford photometry. Sid. Mess., 7: 92.

PICKERING (E. C.) Zone observations made with the transit wedge photometer attached to the equatorial of 15 inches aperture . . . 1882–'86. Ann. Harv. Coll. Obsry. 13: 211–359 (v. 13, pt. 2).

Planets. *See, also,* SOLAR SYSTEM.

[NEWCOMB (S.)]. New tables of the planets. Rept. Supt. Am. Naut. Almanac, 1887: 4.

ROGER (—.) Distances moyennes des planètes au soleil. Compt. Rend., 106: 249.

ZENGER (C. V.) Periods of the planets. Obsry., 11: 87.

Planets (Orbits of).

LOHNSTEIN (T.) Ueber die Gleichungen v. Oppolzer's zur Bestimmung der heliocentrischen Distanzen eines Planeten. Astron. Nachr., 119: 243.

Pleiades.

MOUCHEZ (E.) Nouvelles nébuleuses découvertes à l'aide de la photographie dans les Pléiades. Compt. Rend., 106: 912.

Prague Observatory.

WEINEK (L.) Neuer Zeitbestimmungsraum der Sternwarte in Prag. Sirius, 21: 174, 205.

Precession.

See STAR-PLACES (Reduction of).

Proctor (Richard Anthony). [1837-'88.]

NOBLE (W.) [Obituary notice.] Obsry., 11: 366–368. Knowledge, 11: 265. [Portrait.]

Prominences (Solar). *See, also,* SUN; SUN (Statistics, etc.).

RICCÒ (A.) Grandes protubérances solaires observées à Palerme de 1881 à 1887. . . . il. L'Astron., 7: 215, 254.

Pulkowa Observatory.

OBSERVATIONS de Poulkova . . . v. 14. Déduction des déclinaisons moyennes du catalogue des étoiles principales pour 1865.0. Mémoire de M. Nyrén. Observations faites au cercle vertical 1871-1875. 228 p. 4to. St. Pétersbourg, 1888..(M. 26.40)

SUPPLEMENT 1 aux observations de Poulkova. Beobachtungen der Saturnstrabanten. 1 Abtheilung. 132 p. 4to. St. Pétersbourg, 1888......(M. 10.60)

Refraction.

Gruey (L.-J.) Sur une forme géométrique des effets de la réfraction dans le mouvement diurne. Bull. astron., 5: 91, 193.

Schaeberle (J. M.) Note on a short method for computing the true refractions. Astron. Nachr., 118: 381.

Tuttle (H. P.) Bessel's "log B" for great elevations. Sid. Mess., 7: 406.

Royal Astronomical Society.

Memoirs . . . vol. 49, pt. 1. 237 p. 4°. London, 1888. . . . . (M. 21)

New general catalogue of nebulæ and clusters of stars. By J. L. E. Dreyer.

Saturn.

Elger (T. G.) Physical observations of Saturn in 1888. il. Month. Not., 48: 362–370.

——. [Observations of rings and belts.] Obsry., 11: 153.

Keeler (J. E.) First observations of Saturn with the 36-inch equatorial of the Lick Observatory. il. Sid. Mess., 7: 79–83.

Perrotin (J.) Anneaux de Saturne. Compt. Rend., 106: 1716.

Terby (F.) [Dessins des anneaux et des bandes.] il. Obsry., 11: 195.

——. Premières observations de Mars et de Saturne faites à l'observatoire Lick . . en 1888, et réponses à quelques objections. Ciel et Terre, 9: 370–380.

Trouvelot (E.-L.) Nouvelles observations sur la variabilité des anneaux de Saturne. Compt. Rend., 106: 464–467. *Also*, Reprint.

Saturn (Satellites of).

Hall (A.) Motion of Hyperion. Astron. Jour., 7: 164.

Hill (G. W.) Motion of Hyperion and the mass of Titan. Astron. Jour., 8: 57–62.

Lynn (W. T.) Discovery of Titan. Obsry., 11: 338.

Newcomb (Simon). Mutual action of the satellites of Saturn. Astron. Jour., 8: 105.

Oudemans (J. A. C.) Retrogradation of the plane of Saturn's ring and of those of his satellites whose orbits coincide with that plane. Month. Not., 49: 54–64.

Struve (H.) Beobachtungen der Saturns-trabanten. Abtheilung I. Beobachtungen am 15-zölligen Refractor. 132 p. 4to. St. Petersburg, 1888. . . (M. 10.60)

Supplement 1 aux observations de Poulkova.

Scintillation.

Coleman (W.) Jumping stars. Obsry., 11: 434.

Influence des bourrasques sur la scintillation des étoiles. Ciel et Terre, 9: 489–494.

Maw (W. H.) Jumping stars. Obsry., 11: 404.

Montigny (C.) De l'intensité de la scintillation des étoiles dans les différentes parties du ciel. Bruxelles, 1888.

Repr. from: Bull. Acad. roy. de Belg., 3. s., 16.

Abstr.: Astron. Nachr., 120: 223. *Also, abstr.:* Ciel et Terre, 9: 393–400.

Searle (A.) Apparent instability of stars near the horizon. Astron. Nachr., 120: 109.

Tennant (J. F.) Jumping stars. Obsry., 11: 433.

Weyer (G. D. E.) Sternschwanken. Astron. Nachr., 119: 143.

Sextant.

Comstock (G. C.) Adjustment of a sextant. Sid. Mess., 7: 129–132.

Gruey (L.-J.) Application de l'oculaire nadiral à la détermination des constantes de l'horizon gyroscopique. Compt. Rend., 105: 727–729.

Schaeberle (J. M.) Adjustment of the sextant. Sid. Mes., 7: 223.

——. Eccentricity of the sextant. Astron. Nachr., 118: 383.

Sirius.

Mann (N. M.) System of Sirius. Sid. Mess., 7: 25, 94.

Société astronomique de France.

BULLETIN de la société astronomique de France. Première année: 1887. 128 p. 8vo. Paris, 1888.

FLAMMARION (C.) Discours prononcé à la séance générale annuelle du 4 avril 1888. 15 p. 8vo. Paris, 1888.

Solar system.

FLAMMARION (C.) Les centres de gravité. il. L'Astron., 7: 361–365.

STONE (O.) Motions of the solar system. Proc. Am. Ass. Adv. Sc., 37: 47–59. *Also*, Reprint. *Also:* Science, 12: 89. *Also:* Obsry., 11: 363–366. *Also, abstr.:* Nature, 39: 162.

Spectra (Stellar).

CLERKE (A. M.) Southern star spectra. Obsry., 11: 429–432.

DUNÉR on stars with spectra of Class III. Nature, 37: 234, 260.

ESPIN (T. E.) Stars with remarkable spectra. Astron. Nachr., 118: 257; 119: 309.

——. [Remarkable change in the spectrum of R Cygni.] Astron. Nachr., 119: 365. *See, also: Ibid.*, 120: 41. *Also:* Astron. Jour., 8: 96. *Also:* Month. Not., 49: 18.

VOGEL (H. C.) Zwei Stern Spectraltafeln. [Mit Text.] 100 × 70 cm. Wien, 1888 .... (M. 10)

Spectroscope.

KRÜSS (H.) Automatisches Spektroskop mit festem Beobachtungsfernrohr. il. Ztschr. f. Instrmknd., 8: 388–392.

Spectrum.

JANSSEN (J.) Spectres de l'oxygène. Mem. soc. spettrscp. ital., 17: 31.

——. Spectre tellurique dans les hautes stations. L'Astron., 7: 443–446.

Spectrum analysis.

KURLBAUM (F.) Bestimmung der Wellenlänge einiger Fraunhofer'scher. Linien. 96 p., 1 pl. 8vo. Berlin, 1887.

LANGLEY (S. P.) Energy and vision. Am. J. Sc., 136: 359–379.

Spectrum (Solar).

DÉTAILLE (C.) Photographie du spectre solaire à l'aide de petits instruments. il. L'Astron., 7: 26.

LANGLEY (S. P.) The invisible solar and lunar spectrum. il. Am. J. Sc., 136: 397–410.

MENGARINI (G.) Massimo d' intensità luminosa dello spettro solare. Mem. Soc. spettrscp. ital., 17: 117–129.

Star-catalogues.

AUWERS (A.) Neue Reduction der Bradley'schen Beobachtungen aus den Jahren 1750 bis 1762. 3. Band den Sterncatalog für 1755, und seine Vergleichung mit neuen Bestimmungen enthaltend. 5+352 p. 4to. St. Petersburg, 1888.......... (M. 9.20)

BACKLUND (O.) Ueber die Herleitung der im 8. Bande der Observations de Poulkova enthaltenen Stern-Cataloge, nebst einigen Untersuchungen über den Pulkowaer Meridiankreis. 100 p. 4to. St. Petersburg, 1888.......... (M. 2.80)

BECKER (E.) Resultate aus Beobachtungen von 521 Bradley'schen Sternen am grossen Berliner Meridiankreise. 8vo. Berlin, 1888.

DOWNING (A. M. W.) Positions for 1750.0 and proper motions of 154 stars south of—29° declination, deduced from a revision of Powalky's reduction of the star places of Lacaille's Astronomiæ fundamenta. Month. Not., 48: 322–333.

FRANZ (J.) Zur Bonner Durchmusterung bei 23^h, +8°. Astron. Nachr., 120: 75.

Star-catalogues—Continued.

Marcuse (A.) Ableitung der Sterne des Fundamental-Cataloges der astronomischen Gesellschaft aus den von H. Romberg in den Jahren 1869–1873, am grösseren Meridian-Instrumente der Berliner Sternwarte angestellten Beobachtungen. 84 p. 4to. Berlin, 1888.

Beob.-Ergeb. d. k. Sternw. zu Berlin, Heft 4.

Oertel (K.) Vergleichung der in den "Greenwich Observations" von 1877 bis 1884 enthaltenen Sternverzeichnisse mit den beiden Catalogen der astronomischen Gesellschaft. Astron. Nachr., 118: 177–188.

—— Untersuchungen über die aus Beobachtungen an den Pariser Meridianinstrumenten abgeleiteten Sternpositionen. Astron. Nachr., 119: 194.

Struve (O.) [Declinationen in dem Cataloge von 3542 Sternen.] Astron. Nachr., 119: 81.

Star-charts.

Klein (H. J.) Stern-Atlas enthaltend sämmtliche Sterne der 1–6.5 Grösse zwischen dem Nordpol und 34 Grad südlicher Declination. 8+71 p. 18 maps. 4to. Leipzig, 1888 ....(M. 16)

—— Star atlas, containing maps of all the stars from 1 to 6.5 magnitude between the north pole and 34° south declination, and of all nebulæ and star clusters in the same region which are visible in telescopes of moderate powers. With explanatory text . . . Translated . . . by E. McClure. 72 p., 18 pl. 4to. London and Leipsic, 1888.

Messer (J.) Stern-Atlas für Himmelsbeobachtung. 11+175 p. il. Map. St. Petersburg, 1888..(M. 10)

Schönfeld (E.) Fehlerverzeichniss zur zweiten Serie der Bonner Sternkarten. Astron. Nachr., 119: 31.

Star-clusters.

Clerke (A. M.) Globular star-clusters. Nature, 38: 365.

—— Irregular star-clusters. Nature, 39: 13. *See also, Ibid.*, 61.

Star-places (Reduction of).

Boquet (F.) Note sur la détermination géométrique des positions apparentes des étoiles circumpolaires. Bull. Astron., 5: 137.

—— Application de la méthode de Gaillot. *Ibid.*, 5: 233–237.

Fabritius (W.) Sur le calcul des lieux apparents des étoiles. *Ibid.*, 5: 187–193.

Folie (F.) Sur l'incorrection des formules proposées par Fabritius pour la réduction des circumpolaires. *Ibid.*, 5: 47–50.

—— Sur les formules de M. Fabritius. Réplique aux notes de MM. Gonnessiat et Herz. *Ibid.*, 5: 185, 384.

—— Traité des réductions stellaires. Fascicule 1. Bruxelles, 1888 ......(M. 22)

Repr. from: Bull. Acad. Roy. d. Belg., 1888.

Gonnessiat (F.) Calcul des positions apparentes des étoiles circumpolaires: Méthode de M. Fabritius. Bull. Astron., 5: 135–145.

Herz (N.) Sur la réduction des circumpolaires d'après les formules de Fabritius. *Ibid.*, 5: 145–147.

Safford (T. H.) Reduction of star-places by Bohnenberger's method. Astron. Nachr., 119: 21–28.

—— Note concerning Fabritius's method of reducing from one equinox to another. *Ibid.*, 119: 83.

Schulhof (L.) Sur les formules de M. Fabritius. Bull. Astron., 5: 281–283.

Stars (Distribution of).

Monck (W. H. S.) Note on the distribution of the stars. Sid. Mess., 7: 20–25, 73–77, 105, 236.

Stars (Motion of) in the line of sight.

Spectroscopic results for the motions of stars in the line of sight, obtained at . . . Greenwich . . . 1887. Month. Not., 48: 116–122.

Stars (Motion of) in the line of sight—Continued.

Vogel (H. C.) Bestimmung der Bewegung von Sternen im Visionsradius. Astron. Nachr., 119: 97.

—— Bestimmung der Bewegung von Sternen im Visionsradius durch spectrographische Beobachtung. Mem. Soc. spettrscp. ital., 17: 33.

Sun. *See, also,* Corona; Prominences; Spectrum; Sun (Diameter of), etc.

Flammarion (C.) Les grandes manifestations de l'activité solaire. il. L'Astron., 7: 121–133.

—— Une année de l'histoire du soleil. il. L'Astron., 7: 201–213.

Fritz (H.) Beiträge zur Beziehung irdischer Erscheinungen zur Sonnenthätigkeit. Sirius, 21: 206–210, 217–222, 245–246.

Schulz (J. F. H.) Zur Sonnenphysik. II. 1 pl. Astron. Nachr., 119: 225–242.

Searle (A.) Atmospheric economy of solar radiation. Proc. Am. Acad. Arts and Sc., 26–29. *Also,* Reprint.

Sun (Diameter of).

Wellman (V.) Einfluss der Blendgläser bei Beobachtungen des Sonnendurchmessers. Astron. Nachr., 119: 241.

Sun (Rotation of).

Crew (H.) Period of the rotation of the sun as determined by the spectroscope. Am. J. Sc., 135: 151–159.

Wilsing (J.) Ableitung der Rotationsbewegung der Sonne aus Positionsbestimmungen von Fackeln. Astron. Nachr., 119: 311–316.

Sun (Statistics of faculæ, prominences, and spots).

Flammarion (C.) Fluctuations de l'activité solaire depuis le dernier maximum de 1883–'84 jusqu'au delà du dernier minimum. Taches facules, éruptions et magnétisme terrestre. il. L'Astron., 7: 41–53.

Spoerer (A.) Verschiedenheit der Häufigkeit der Sonnenflecken auf der nördlichen und südlichen Halbkugel in den Jahren 1886 und 1887. Astron. Nachr., 118: 307.

Tetens (O.) Sonnenflecke im Jahre 1887 nach den Beobachtungen zu O'Gyalla. Astron. Nachr., 119: 267.

Wolf (R.) Sonnen-Statistik des Jahres 1887. Astron. Nachr., 118: 307.

Sun-spots.

Bossi (B.) Le macchie solari; cause ed effetti. Sui terremoti avvenuti e futuri come da predizioni dell' autore. 3. ed., enl. 116 p. 16mo. Genova, 1888. (M. 1.50)

Faye (H.) Remarques sur une objection de M. Khandrikoff à la théorie des taches et des protubérances solaires. Compt. Rend., 106: 399–403.

—— Taches et protubérances solaires. L'Astron., 7: 89–93.

Tables (Logarithmic).

Nell (A. M.) Fünfstellige Logarithmen . . . 6. ed. 19+104 p. 8vo. Darmstadt, 1888 .... (M. 1.80)

Taschkent Observatory.

Pomerantzeff (H.) Latitude de l'observatoire de Tachkent. Astron. Nachr., 119: 317.

[Memoirs of the Taschkent astronomical and physical observatory. Publication II.] 104 p. 4to. Москва, 1888.

Telegrams (Astronomical). *See* Code (Astronomical).

Telescopes. *See, also,* Equatorials; Mirrors; Objectives.

Crossley (E.) Improved centering tube for reflecting telescopes. Month. Not., 48: 280.

Grubb (H.) Good asfronomical telescopes. Sid. Mess., 7: 106, 259.

Harkness (W.) Visibility of objects as conditioned by their magnitude and brightness with applications to the theory of telescopes. *Abstr.:* Proc. Am. Assn. Adv. Sc., 36: 64.

Telescopes—Continued.

SMITH (H. L.) Telescopes of short focal length. Sid. Mess., 7: 293-296, 360.

TENNANT (J. F.) Note on the definition of reflecting telescopes, and on the images of bright stars on photographic plates. Month. Not., 48: 104.

TODD (D. P.) American telescopes. 4 p. 4to. [Philadelphia? 1888.]
Repr. from: Encyc. Brit. Amer. Reprint. Vol. 23, Appendix, p. 932-936.

Temple Observatory.

SEABROKE (G. M.) Report . . . 1888. 3 p. 8vo. [n. p., n. d.]

Three bodies (Problem of).

CHARLIER (C. V. L.) Ueber eine mit dem Problem der drei Körper verwandte Aufgabe. 18 p. 4to. St. Petersburg, 1888 ....(M. 0.80.

HARZER (P.) Argumente des Problems der *n* Körper. Astron. Nachr., 120: 193-218.

Time (Determination of).

BIGELOW (F. H.) Computation of clock corrections. Sid. Mess., 7: 97-100.

Time (Standard).

BOUQUET DE LA GRYE (J.-J.-A.) Note sur l'adoption d'une heure légale en France. Compt. Rend., 107: 429.

FOREL (F.-A.) L'unification de l'heure: l'heure nationale. L'Astron., 7: 327-333.

LAUSSEDAT (A.) L'heure nationale. L'Astron., 7: 454-457.

Transit instrument.

BIGELOW (F. H.) An automatic transit instrument. il. Sid. Mess., 7: 205-209.

BIGOURDAN (G.) Disposition qui permettrait l'emploi de puissants objectifs dans les observations méridiennes. Compt. Rend., 106: 998.

DEVAUX (—.) Recherches sur la forme des tourillons d'une lunette méridienne. Bull. astron., 5: 523-532.

FÖRSTER (W.) Theorie des Durchgangs-Instrumentes. *In his:* Studien zur Astrometrie, 50-114.

GEELMUYDEN (H.) Collimation des lunettes brisées. Astron. Nachr., 119: 151, 183.

GRUEY (L.-J.) Nouvel oculaire pour les observations méridiennes. Compt. Rend., 106: 585-587.

REPSOLD (J.) Durchgangs-Instrument mit Uhrbewegung. Astron. Nachr., 118: 305.

Transit observations.

GONESSIAT (F.) Quelques erreurs affectant les observations de passages. Compt. Rend., 107: 647-650.

RAYET (G.) Recherches sur les erreurs accidentelles des observations de passages dans la méthode de l'œil et de l'oreille. Compt. Rend., 106: 1713-1716.

United States Naval Observatory.

CIRCULAR relating to the construction of a new naval observatory. 44 p. 12mo. Washington, 1888.

ESTIMATE for the purchase of photographic telescope and pointers, and construction of buildings for same, for the proposed international project of charting the sky. 4 p. 8vo. [Washington, 1888.] 50th Congr., 2d sess., House of Rep., Ex. Doc. 46.

REPORT of the Superintendent . . . June 30, 1888. 24 p. 8vo. Washington, 1888.

Urania.

URANIA—Volksakademie der Naturwissenschaften in Berlin. Sirius, 21: 84-88.

Variable stars.

CHANDLER (S. C.) Period of Algol. Astron. Jour., 7: 165, 177.

——. On the observation of the variables of the Algol type. *Ibid.*, 7: 187.

——. New variable of long period. *Ibid.*, 8: 24.

Variable stars—Continued.

——. Ephemeris of variables of the Algol type. *Ibid.*, 8: 40.

——. Catalogue of variable stars. 14 p. 4to Lynn, 1888. *Repr. from:* Astron. Jour., 8: 81-96 (Nos. 179-180).

——. Observation of the fainter minima of the telescopic variables. Astron. Jour., 8: 114-117.

——. Some remarkable anomalies in the period of Y Cygni. *Ibid.*, 8: 130.

——. Colors of the variable stars. *Ibid.*, 8: 137-140.

Clerke (A. M.) Variable double-stars. Obsry., 11: 188.

Espin (T. E.) [Discovery of variability of DM. +40°, 2694, $13^h\ 42^m\ 43^s$; +40° 15′.9 (1855) 1888, Apr. 6.] Astron. Nachr., 119: 39.

——. [New star in Cygnus.] *Ibid.*, 119: 127.

——. Variable star near 26 Cygni. *Ibid.*, 119: 307.

Lockyer (J. N.) Maximum of Mira Ceti [and its spectrum]. Nature, 38: 621. *See, also:* Compt. Rend., 107: 832.

Oudemans (J. A. C.) Request to observers of variable stars. Month. Not., 48: 85.

Plassmann (J.) Beobachtungen veränderlicher Sterne angestellt in den Jahren 1881-1888. Mit Erläuterungen und Notizen über die Helligkeit der Planeten Venus und Uranus und anderer Sterne. 44 p. 8vo. Münster, 1888......(M. 2)

Beilage. zum Jahresb. d. math.-phys.-chem. Sect. d. westfäl. Provinzialver. f. Wissensch. und Kunst, Münster, 1888.

Safarik (A.) Zwei neue veränderliche Sterne in den Sternbildern Cetus und Sagittarius. Astron. Nachr., 119: 109.

——. Lichtwechsel einer Anzahl von Sternen aus der Bonner Durchmusterung und aus den Katalogen rother Sterne von Schjellerup und Birmingham. 16 p. 8vo. Prag, 1887..(M. 1.20)

Sawyer (E. F.) [Observations and period of U Ceti.] Astron. Journ., 7: 185.

——. [Observations and period of T Vulpeculæ]. *Ibid.*, 8: 5.

——. Definitive discussion of observations of U Ophiuchi. *Ibid.*, 8: 70.

——. Observations of some suspected variable stars. *Ibid.*, 8: 121-125.

Venus.

Elger (T. G.) Visibility of the unilluminated part of Venus. Obsry., 11: 198.

Lynn (W. T.) Visibility of the unilluminated part of Venus. *Ibid.*, 11: 155.

Venus (Transit of).

Harkness (W.) Value of the solar parallax deducible from the American photographs of the last transit of Venus. Astron. Jour., 8: 108.

Vienna Observatory.

Annalen . . . 6. Bd. Jahrg., 1886. 3+160 p. 4°, Wien, 1888.

Watson (James Craig.) [1838-'80.]

Comstock (G. C.) Biographical memoir of James Craig Watson. [Portr.] Sid. Mess., 7: 273-286.

Williams College Observatory.

Safford (T. H.) Commemoration of the 50th anniversary of the dedication of the Hopkins Observatory. 32 p. 8vo. Williamstown, 1888. *Also:* Sid. Mess., 7: 430.

Wolsingham Observatory.

Espin (T. E.) [Site of new observatory]. Astron. Nachr., 120: 191.

Yale College Observatory.

Report for the year 1887-'88 . . . 16 p. 8vo. [New Haven, 1888.]

Zodiacal light.

Barnard (E. E.) Observations of the zodiacal counterglow. [1883-'87.] Astron. Jour., 7: 186.

Sherman (O. T.) [Connection between the zodiacal light and sun-spots.] Nature, 38: 595; 39: 128. *See, also:* Science, 12: 180.

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AN ACCOUNT OF THE PROGRESS

IN

ASTRONOMY

FOR

THE YEARS 1889-'90.

BY

WILLIAM C. WINLOCK.

FROM THE SMITHSONIAN REPORT FOR 1890.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1891.

PROGRESS OF ASTRONOMY FOR 1889, 1890.

By William C. Winlock.

The following record of astronomy for the years 1889 and 1890 is presented in essentially the same form as its predecessors. The compiler has made free use of reviews, in the various branches of astronomy, contributed by specialists to the *Athenæum*, *Nature*, *Journal of the Astronomical Society of the Pacific*, the *Observatory*, *Bulletin Astronomique*, the *Astronomical Journal*, and other periodicals.

NEBULÆ.

Motions of the planetary nebulæ in the line of sight.—No. 11 of the Publications of the Astronomical Society of the Pacific contains a very important paper by Mr. James E. Keeler on the "Motions of the planetary nebulæ in the line of sight." The paper is an important one in a twofold aspect: first, in its bearing on a matter just now under discussion by the highest authorities, as to the character and position of the brightest nebular line, and secondly, in the evidence it affords of nebular movements.

As to the character of the nebular line, Mr. Keeler's testimony is most emphatic, and entirely confirms Dr. Huggins's observations. "The nebular lines," he reports, "appeared to be perfectly monochromatic images of the slit, widening when the slit was widened and narrowing to excessively fine sharp lines when it was closed up." The chief nebular line "showed no tendency to assume the aspect of a remnant of fluting under any circumstances of observation." This observation, made not on one nebula, but on a number, and with a dispersion often equivalent to that of 24 prisms of 60°, for the fourth spectrum of a Rowland's grating of 14,438 lines to the inch was often used, is by far the strongest evidence we have yet had on this question of the character of the chief nebular line, and it is dead against Mr. Lockyer's theory.

The position of the nebular line is also fixed with very considerable certainty; and here, again, Dr. Huggins's observations receive complete confirmation. It was not, in any one of the nebulæ observed, coincident with the fluting of magnesium, but was always seen some distance to the blue. The importance of this observation, especially when taken with the report as to the character of the line, is of the highest kind in its bearing on Mr. Lockyer's great meteoritic theory. If the chief nebular line is not the remnant of the magnesium fluting the very keystone is knocked away from the arch and the edifice as such falls to pieces. No doubt there would be many isolated fragments of considerable value still left. The structure might even be put together again, hereafter, on a new plan, and with a more lasting result, but the theory as it now stands—the theory as a whole—would be irretrievably wrecked. On the other hand, if the identity which Mr. Lockyer asserts were established, it would be a victory for him of the first importance.

It is indicative of the progress of practical spectroscopy that the whole question turns on an almost inappreciable difference of position, the mean value for the wave-length of the nebular line as found by Mr. Keeler from ten nebulæ, being 5,005.68 tenth-meters, whilst that of the fluting of magnesium is 5,006.36. In the brightest nebula examined the wave-length obtained was 5,006.13 tenth-meters, only 0.23 distant from the magnesium fluting. As the observations stand they point strongly to the nebular line being slightly but distinctly more refrangible than the edge of the magnesium fluting, and therefore not due to it. But the amount of displacement is not so great as to make it altogether inconceivable that it is due to the relative motion of the nebulæ and the solar system, for all the ten nebulæ observed are in that hemisphere toward which the sun is travelling, and seven of them are within 45° of the apex of the "Sun's Way," so that a correction must be applied which would tend to bring the nebular line nearer to the fluting; how much nearer we cannot, in our ignorance of the speed of the sun's motion in space, at present say, but a rate of 36 miles per second would suffice to make the accord a perfect one. If Mr. Keeler could obtain a series of comparisons of the *F* line in these nebulæ with hydrogen, the problem would be solved. Or the determination of the place of the line in a number of nebulæ in the hemisphere we are leaving would go far to settle the matter. In the mean time it is still *possible* that the eventual result may favor Mr. Lockyer's theory. It may be added in reference to Mr. Lockyer's paper, appearing in No. 293 of the Proceedings of the Royal Society, that if we accept Mr. Keeler's measures it is clear that Mr. Lockyer did not employ sufficient dispersion to decide the point at issue.

The second point brought out by Mr. Keeler's measures is the fact that the nebulæ have very distinct movements of their own. As we do not yet know to what substance the chief nebular line is due, and as Mr. Keeler could not make any measures of the blue hydrogen line in the nebulæ at all comparable in accuracy to those he made of the chief line, we can not say that the difference in position of the chief line from any given comparison line is due to the motion of the nebula. All we can do at present is to observe a number of nebulæ, adopt the mean place they give as the true position of the nebular line, and record the differences from this mean as due to differences of motion from the mean motion. The extreme difference observed between any two nebulæ amounted to very nearly 70 miles per second.

It is impossible to leave this paper without a word on the accuracy of the measures. The spectrum of Σ 6 was examined on nine nights. The greatest difference of any one night's observation from the mean was only 0.11 tenth-metre, or in miles per second 4.2; the mean difference but 0.04, or in miles per second 1.5. Such accuracy was only possible by using an enormous dispersion, and it implies very perfect instrumental and atmospheric conditions. But it also implies an extreme delicacy of eye and hand in the observer; the "man behind the telescope" is in evidence. For it should be remembered that the great size of the Lick telescope is no special advantage in work of this particular class, its high proportion of focal length to aperture being a distinct disadvantage. A much smaller object-glass, with a focal length of 12 to 1, would give brighter images.—(E. W. MAUNDER. *The Observatory*, No. 168.)

Mr. Lockyer having published some results at variance with those obtained by Dr. and Mrs. Huggins with respect to the principal line in the spectrum of the great nebula in Orion, they have made careful re-determinations, decisively confirming their previous results: (1) that the principal line is not coincident with, but falls within, the termination of the magnesium flame band; (2) that in the nebula in Orion this line presents no appearance of being a "fluting."

The faint star discovered in the trapezium of the Orion nebula by Alvan Clark, when the Lick telescope was first mounted, has been found by Barnard to be double, another star has also been detected in the trapezium by Barnard, and also one of about the same magnitude (sixteenth) as the Clark star just preceding the trapezium.

Within the ring of the well-known ring nebula of Lyra six stars have been found by Holden and Schaeberle with the 36-inch Lick telescope where but one was known before, and five new stars have been found in the nebulosity.

ASTRONOMICAL CONSTANTS.

Refraction.—M. Radau has published in volume 19 of the Paris Observatory *Annales* a very complete memoir on astronomical refraction, which deals with the theoretical as well as the practical side of the question, and contains complete tables in a convenient form suitable for actual computation.

Diurnal nutation.—M. Folie's work on diurnal nutation has not met with general acceptance. One of the latest discussions of the subject is that by Herr Lehman Filhés, published in No. 2975 of the *Astronomische Nachrichten.*

Precession.—A useful table of the third term of the precession has been computed by Herr Kloock and published by the Kiel Observatory.

Harkness's astronomical, physical, and geodetic constants.—Prof. Wm. Harkness, of the U. S. Naval Observatory, has been at work for some time upon a homogeneous system of inter-related constants, more trustworthy values of which are to be attained by the solution of equations of condition, in which the best values resulting from observation are introduced and combined with the expression of their mutual relations.

A preliminary communication of results was made to the Astronomical Journal, No. 194, but it seems preferable to quote here the final values published by Professor Harkness in Appendix III to the Washington Observations for 1891, though the latter work was not issued till after the close of the year 1890.

Professor Harkness has collected the various determinations of each of the constants in question, decided upon the values to be adopted in the computations, often using the method of least squares for this purpose; and has then employed this method in order to obtain a resultant homogeneous system.

Among the results obtained are the following:

Earth's equatorial semi-diameter	6,377 972 ± 1 248 meters.
Earth's polar semi-diameter	6,356 727 ± 99.1 meters.
Length of seconds-pendulum	$0^{m}.990\ 91 + 0^{m}.005\ 29 \sin^2\varphi$.
Length of sidereal day	86 164.099 65 mean solar seconds.
Length of sidereal year	$365^{d}\ 6^{h}\ 9^{m}\ 9^{s}.314$.
Solar parallax	8″.809 05 ± 0″.005 67.
Lunar parallax	3 422″.542 16 ± 0″.125 33.
Constant of aberration	20″.454 51 ± 0″.012 58.

The mean distance of the earth from the sun, with the above value of the solar parallax is 92,796 950 ± 59 715 miles, or 149,340 870 ± 96 101 kilometers.

STAR CATALOGUES.

The star catalogue of the Astronomische Gesellschaft.—The first parts of the great catalogue of the Astronomische Gesellschaft appeared in 1890. They are the volumes containing the catalogues of zones observed by Krueger at Helsingfors and Gotha, by Boss, at Albany, and by Fearnley and Geelmuyden at Christiania. The two first mentioned volumes contain respectively the positions of 14,680 and of 8,241 stars for the equinox of 1875.

It may be worth while to recall here the origin of this great undertaking, now nearing completion. The zones of the *Histoire céleste française*, published by Lalande comprise about 50,000 stars from the first to the eighth magnitude, but they were not catalogued till nearly half a century after their completion. Those of Bessel, observed at Koenigsberg from 1821 to 1833, contain 62,600 stars from the first to the ninth magnitude between −15° and + 45° declination; the two catalogues of Weisse appeared in 1846 and 1863. From 1841 to 1852 Argelander continued his work at Bonn, and his northern zones (published in 1846) contain 22,000 stars between +45° and +80° and the southern zones (published in 1852) 17,000 between −15° and −31°, catalogued by Oeltzen (1851 to 1857). The positions in these different catalogues depend upon meridian observations.

In 1852, having finished his zones, Argelander conceived the plan of a work of much greater extent. It was to fix approximately the positions of all stars to the ninth magnitude, and perhaps a little below (9.5), visible in our latitudes. To accomplish this the plan was to employ simply a small telescope, the observer, with his eye always at the telescope, to call out to a recorder, who sat close by with a chronometer. The preliminary trials, by J. Schmidt, being successful, the work was begun, and, with the help of Krueger and Schoenfeld, on whom the greater part of the labor fell, the revision of the northern sky was finished in 1859; and this is the work that we know as the "Bonn Durchmusterung."

The Durchmusterung, published between 1859 and 1862 in volumes 3, 4, and 5 of the Bonn Observations, contains no less than 324,198 stars, lying between 2° south declination and the north pole, the zone between +81° and the pole being a revision of Carrington's catalogue. Volume 6 of the "Bonn Beobachtungen," contains futhermore 34,000 positions, determined by Argelander with the meridian circle. The stars of the Durchmusterung are plotted on a series of charts published in 1863. Since Argelander's death Schoenfeld has completed a similar piece of work for our southern sky, the "Südliche Durchmusterung" (1886), containing more than 133,000 stars, between −2° and −23°, and Gould at Cordoba has extended the zones to the neighborhood of the south pole.

Upon the organization of the International Astronomische Gesellschaft in 1865, the question at once came up of undertaking, by the co-operation of several observatories, the exact determination of the positions of all these stars provisionally catalogued in the Durchmusterung. A programme for the work, prepared by a special committee, was finally decided upon at the meeting in Vienna in 1869. The new revision was confined to the limits of −2° and +80° declination, the positions of the circumpolars seeming to be sufficiently well known from the work of Carrington and that of the astronomers at Hamburg and Kazan. The zones were at first assigned as follows:

80° to 75°	Kazan.	35° to 30°	Leipzig.
75 to 70	Dorpat.	30 to 25	Cambridge (England).
70 to 65	Christiania.	25 to 15	Berlin.
65 to 55	Helsingfors.	15 to 10	Leipzig.
55 to 50	?	10 to 4	Mannheim.
50 to 40	Bonn.	4 to 1	Neufchâtel.
40 to 35	Chicago.	+1 to −2	Palermo.

Pulkowa undertook the determination of 539 fundamental stars carefully selected by Dr. Auwers, which should form points of reference.

In the 20 years that have elapsed since the great catalogue was decided upon several changes have been made in the original programme, the work being eventually divided up among the following observatories:

80° to 75°	Kazan.	35° to 30°	Leyden.
75 to 70	Dorpat.	30 to 25	Cambridge (Eng.)
70 to 65	Christiania.	25 to 15	Berlin.
65 to 55	Helsingfors-Gotha.	15 to 5	Leipzig.
55 to 50	Cambridge (U. S.).	5 to 1	Albany.
50 to 40	Bonn.	+ 1 to −2	Nicolaief.
40 to 35	Lund.		

The work of observation is now finished. Some of the zones have been published (Kazan, Christiania, Helsingfors, Lund), others are in press, and the catalogues have been begun. Three of the catalogues (Albany, Helsingfors-Gotha, and Christiania,) have just appeared. Meanwhile the zones have been extended to the southern sky, the following being to a greater or less extent under way:

−2° to − 6°	Strasburg.	−14° to −18°	Washington.
−6 to − 10	Vienna.	−18 to −23	Algiers.
−10 to − 14	Cambridge (U. S.).		

The positions of the 303 fundamental southern stars are furnished by observations undertaken at the Cape of Good Hope, Madison, Annapolis, Carlsruhe, Leiden, and Strasburg. Gould's southern zones extend from −23° to −80°, and it is to be hoped that before long we shall have a catalogue embracing the whole sky, the value of which will be in no wise diminished by the photographic chart which is about to be begun.

The observations for the Helsingfors-Gotha catalogue were made almost entirely by Dr. Krueger with a $0^m.15$ (5.9 inch) Reichenbach meridian circle. The star positions are for the epoch 1875, and besides the right ascension and declination, the precession and secular variation, and wherever possible the proper motion are given. The observations for the Albany zone were made by Professor Boss with a $0^m.20$ (7.9 inches) Pistor & Martin's meridian circle, the transits being recorded on the chronograph, while Dr. Krueger used the "eye-and-ear" method.

The probable errors come out:

	In right ascension.	In declination.
Helsingfors	$\pm0^s.101$	$\pm0''.51$
Gotha	.125	.76
Albany:		
2 observations	.025	.39
3 observations	.021	.32
4 observations	.018	.27

Experiments were made with wire-gauze screens by Professor Boss to determine the effect of difference of magnitude upon the observations, his result being that a change of one magnitude produced a change of $0^s.014$ in the personal equation in observing a transit.

A third installment of the catalogue, that containing the stars from +64° 50′ to +70° 10′, has also appeared. The observations were made by Professors Fearnley and Geelmuyden with the Ertel meridian circle of the Christiania Observatory, of 48 lines aperture. The probable error of a single observation is given as $\pm 0^s.054$ in right ascension ($\pm 0^s.02$ in a great circle) and $\pm 0''.54$ in declination.

Yarnall's catalogue.—A third edition of the catalogue of southern stars observed with the transit instrument and mural circle at the U. S. Naval Observatory from 1845 to 1877 has been published, the work of revision having been conducted by Professor Frisby. Great pains have been taken to eliminate all errata detected in the previous editions, both by the careful examination of published lists of corrections and by comparisons with other catalogues. The whole number of stars in the new edition is 10,964.

Munich catalogue.—Band 1 of the "Neue Annalen der k. Sternwarte in Bogenhausen bei München" contains a catalogue of 33,082 stars down to the tenth magnitude inclusive, between —32° and +24° declination, reduced to the epoch 1880.0. The observations were made with a Reichenbach meridian circle of 109^{mm} (4.3 inches) aperture and circle of 0.95^{m} (37.4 inches) diameter.

Second Melbourne catalogue.—This catalogue contains the results of observations made with the old transit circle of 5 inches aperture from the beginning of 1871 to the end of August, 1884; places of 1,211 stars are given for 1880.

Brussels catalogue.—The Brussels catalogue contains 10,792 stars for the epoch 1865, observed with the Brussels transit instrument and mural circle in the years 1857—1878; the general catalogue is preceded by the positions of the fundamental stars used in the reductions. A supplement is to be published giving corrections to the catalogue due to a number of inaccuracies detected in the reductions.

The Williams College catalogue of north polar stars.—Professor Safford has published a catalogue of right ascensions of 261 stars, mostly within 10° of the north pole, and observed by him with the 4½-inch Repsold meridian circle of the Field Memorial Observatory at Williamstown. The results have been reduced to the epoch 1885.0. Professor Safford characterizes his catalogue as an "attempt to strengthen the weak point of all our standard catalogues—the right ascensions of polar stars," and he draws the following conclusions from his work.

"First. That it is highly conducive to accuracy, systematic as well as in detail, to base a catalogue of polar right ascensions upon standard places in all hours of right ascension, rather than upon double transits alone.

"Second. That the introduction of meridian marks according to Struve (long-focus object glasses, also suggested by Rittenhouse) is a great advantage to the primary catalogues.

"Third. That the eye-and-ear method should be retained as the standard within a narrow rather than a wide range of polar distance.

"Fourth. That modern meridian instruments are subject to irregular small changes of position, which are not direct functions of the temperature; so that in all differential work it is better to keep a close watch upon clock rate and instrumental adjustments rather than to trust the instrumental zero points for more than 2 hours without redetermination of the most essential.

"Fifth. That the right ascensions here given are reasonably accurate-

"Sixth. That a thorough comparison of the chronographic and eye-and-ear method within a wide range, both of magnitude and declination, is desirable."

Greenwich 10-*year catalogue*, 1877 *to* 1886, published in the volume of Greenwich Observations for 1887, contains 4,059 stars for the epoch 1880.0.

The catalogue of 303 reference stars for the southern zones of the Astronomische Gesellschaft has been published by Dr. Auwers, and although the material accumulated since 1880, when the provisional list was issued, is not sufficient to give places of a thoroughly satisfactory degree of accuracy, the final corrections will probably be extremely small.

A collection of all available meridian observations of stars that will be within 1° of the north pole in 1900 has been prepared, under the direction of Professor Pickering, by Miss Winlock and published as the ninth memoir in volume 18 of the Harvard Observatory Annals.

STELLAR PARALLAX.

Professor Pritchard intends to examine for parallax, by the aid of photography, all stars of the second magnitude suitably situated for observation at Oxford, in the hope of contributing to our knowledge of what Herschel called the "construction of the heavens." With reference to the differences in the results obtained by different observers, Professor Pritchard says: "Guided by the suggestions of recent experience, I now think that such differences of 'parallax' might very reasonably have been anticipated and may probably be accepted as matters of fact without in any degree impugning the accuracy of the observations. For in process of this work on parallax, and also from the general history of similar inquiries, it has been made abundantly evident that no necessary connection exists between the brightness of a star and its position in space, or distance from the sun. Nevertheless it is this very difference of brightness mainly which guides us in the selection of comparison stars. The 'parallax' is, in fact, and is becoming more and more generally recognized to be, a differential quantity, fainter stars being in very many instances much nearer to us than others possessing incomparably greater brightness. In passing I may here instance α Lyræ as compared with 61 Cygni; β Centauri as compared with ε Indi. In fact, the position in space of the faint comparison stars in relation to that of the star whose parallax is sought is, if not a matter of accident, at all events wholly unknown until the observations and computations are complete."

Professor Pritchard's results for stellar parallax, as published in the third volume of the Oxford Observations, are as follows:

Star.	Magnitude.	Proper motion.	Parallax.
		"	"
61¹ Cygni	4.98	5.16	0.44
61² Cygni	4.98	5.16	0.44
μ Cassiopeiæ	5.40	3.75	0.04
Polaris	2.05	0.05	0.08
α Cassiopeiæ	2.41	0.05	0.04
β Cassiopeiæ	2.32	0.55	0.16
γ Cassiopeiæ	2.19	0.02	0.01
α Cephei	2.57	0.16	0.06

The greater part of this volume is devoted to a discussion of the parallax of 61 Cygni and the results seem to justify his remark that "the four comparison stars probably belong to a remote system not containing 61 Cygni." The probable errors deduced are small.

At the annual visitation to the Oxford Observatory on June 12, 1890, Professor Pritchard announced the results of the determination of parallaxes of six more stars by the photographic method, as follows:

	Parallax.	Prob. error.
	"	"
ε Cygni	+ 0.115	± 0.034
γ Cygni	— .040	.029
β Andromedæ	+ .092	.023
α Arietis	+ .080	.027
α Persei	+ 0.74	.029
β Ursæ Minoris	+ .022	.030

The subjoined table forms a summary of a paper published in the Astronomische Nachrichten, Nos. 2915 and 2916, by Dr. Oudemans, in which he collects the scattered results for stellar parallax obtained in the past sixty years. Dr. Oudemans concludes that "stars with proper motions greater than 0."05 have probably an annual parallax of 0."10 to 0."50.

No. of stars.	Proper motion.	Annual parallax.	Distance in light years.
	"	"	
9	4.93	0.32	10
9	2.33	.20	16
9	1.00	.20	16
9	0 38	.18	18
10	0.05	.16	20

PROPER MOTIONS.

Professor Boss has published in the Astronomical Journal the proper motions of 295 stars of the Albany zone (+ 0° 50′ to + 5° 10′).

In the *Bulletin Astronomique* for March, 1890, is a most useful catalogue, compiled by Bossert, of all stars whose proper motion is known to exceed 0.″50. They are thus distributed:

No. of stars.	Proper motion greater than
	″
5	5.0
4	4.0
6	3.0
9	2.0
11	1.5
30	1.2
15	1.0
38	0.8
77	0.6
73	0.5

DOUBLE AND MULTIPLE STARS.

Some very elegant and simple formulæ for determining the true orbit of a binary star, originally published in Russian, have been brought out by Professor Glasenapp.

ξ *Scorpii.*—Herr Schorr has made a study of the motions in this triple system by methods similar to those employed by Dr. Seeliger on ζ Cancri. The star is known as Σ 1998, the magnitudes of its components being A = 3.9, B = 5.2, C = 7.2.

η Ophiuchi has been divided into two nearly equal components by Burnham with the 36 inch Lick telescope, and he thinks that it will prove to be a binary of short period. He has also found companions for Aldebaran, γ Cassiopeiæ, and δ Cygni, and has been able to separate and measure a companion to the principal star in the pair ε Hydræ, the existence of which was suspected by previous observers.

Photographs of the spectrum of Spica have put beyond question the reality of its motion in the direction of the line of sight. Dr. Vogel has deduced from observations of 1889 and 1890 a period of revolution of about 4 days.

PHOTOMETRY.

The results of observations made with the meridian photometer of the Harvard observatory by Prof. E. C. Pickering and Mr. Wendell during the years 1882-1888, have appeared as volume 24 of the Harvard Annals. The principal work done with this instrument was "the determination of the magnitudes of a sufficient number of stars contained in the Durchmusterung, and distributed with approximate uniformity, to serve for future estimates or measures of magnitude, and to enable previous estimates to be reduced to the photometric scale."

The number of stars of which observations are recorded is 20,125; so that when the stars enumerated in volume 26 of the Annals are reckoned, the total number of stars observed reaches 20,982. Measures have also been made of 166 variable stars and of several planets and satellites. In the "Harvard Photometry" the brightest stars were compared solely with Polaris. In the present observations λ Ursæ Minoris was selected as the standard star, but the results are made to depend upon a series of 100 circumpolar stars, the magnitudes of which were frequently determined with the smaller instrument.

Photographic photometry.—The readiest and most effective means of determining the magnitudes of stars from an examination of the disks impressed on a sensitized film is a problem that has received much attention recently, and contributions to the literature of the subject have been made from the three observatories of Harvard, Stockholm, and Potsdam.

Professor Pickering gives in volume 18 of the Harvard Annals three catalogues of magnitudes, embracing, on the whole, some 2,500 stars, the first catalogue giving the photographic magnitudes of all the stars brighter than the fifteenth magnitude within 1° of the pole; the second, the magnitudes of many of the stars in the Pleiades; and the third the magnitudes of 1,131 stars generally brighter than the eighth magnitude near the equator.

The contribution from the Potsdam observatory is confined to the discussion of the magnitudes of stars in the Pleiades as impressed on plates taken with a chemically corrected object-glass by Dr. Scheiner, and with the reflecting telescope of the Herény observatory, supplemented by some photographs of the artificial stars in a Zöllner photometer. The principal results of the inquiry are twofold: first, that the increase of the diameter of the star disk varies as the square root of the time of exposure; and secondly, that a simple linear relation exists between the observed diameter and the magnitude.

The third contribution to this subject is from Dr. Charlier, of Stockholm, who deduces a formula which expresses the connection between the photographic brilliancy of a star and its photographed image in such a manner as to insure a coincidence as far as possible between the photographic and photometric magnitudes.

VARIABLE AND COLORED STARS.

Chandler's catalogue of variable stars.—Chandler's admirable catalogue of variable stars has been adopted by Schoenfeld in the ephemerides published in the Vierteljahrsschrift, and it also furnishes the data for the ephemerides of the Annuaire du Bureau des Longitudes and the Observatory, and is thus formally recognized as the standard authority on variables. Mr. Chandler publishes in the Astronomical Journal (No. 216) three tables supplementary to the catalogue, containing (1) a list of new variables arranged as in the original catalogue; (2) a list of additions and corrections to the elements of the catalogue; and (3) a list of stars probably variable, but whose variability needs further confirmation before definitive letters can be assigned. The attention of observers is directed to this list.

Taking his catalogue of 1888 as a basis, Mr. Chandler has made an investigation of the relation existing between the lengths of the periods and the number of the variables; their color, range of fluctuation, forms of light curves, irregularities of periods and of light variations. Periods under 20 days predominate, while for the long-period stars a well-marked maximum is indicated about a period of 320 days. With regard to color, the redder the tint the longer the period; and with regard to range of fluctuation, while it is probable that there is a dependence of range upon the duration of the period, the relation is not one of strict proportionality of range to period. It furthermore appears that the average ratio of increase to decrease for stars with periods less than 100 days is about 0.65; between 100 and 200 days it is slightly in excess of unity; it then declines as the periods lengthen; at first, gradually, but in the neighborhood of a year, with extraordinary suddenness, recovering as quickly until it again exceeds unity in the group of extremely long periods. In the case of the numerical laws of the perturbations of the periods, Mr. Chandler remarks that his researches are not yet complete, but that, broadly, in the case of long-period variables, the irregularities are periodic in their nature, and in the case of those of short period, secular and exceptional.

Algol.—Prof. H. C. Vogel, of Potsdam, has published the results of some interesting observations of the changes in the spectrum of Algol at the times of the diminution and recovery of its light. These, whilst fully confirming the view originally suggested by Goodricke, that the periodic variability of this star is caused by the revolution of a dark companion cutting off part of its light in the manner of an eclipse, and the calculation of Professor Pickering that the diameter of the companion amounts to about eight-tenths of that of the principal star, have enabled Professor Vogel to obtain approximate values of the mutual distance and actual sizes and masses of the two stars, as well as of their orbital velocities round their common center of gravity. He finds, in fact, that their diameters are probably about 1,080,000 and 850,000 English miles respectively; that the distance of their centers from each other amounts to about 3,290,000 miles, and that the orbital velocity of Algol is about 27, whilst that of its companion is about 56 miles. The mass of the former he determines to be about double that of the latter, the one being approximately four-ninths and the other two-ninths of the sun's mass. It is not necessary, he remarks, to suppose that the companion is absolutely opaque, but only that its light is very much feebler than that of the principal star.

It may be added that the Greenwich observations confirm Dr. Vogel's conclusion of the motion of the star in a small orbit.

A remarkable star of the Algol type, having the shortest period known, was discovered in 1888 by Prof. H. M. Paul, of the U. S. Naval Observatory. The star is 12 Antliæ of Gould's Uranometria Argentina, $\alpha=9^h\ 26^m\ 50^s$, $\delta=-28^\circ\ 4.7$ (1875.0). The range of magnitude is 6.7 to 7.3, and according to Chandler it goes through its changes in $3^h\ 20^m$.

From an examination of one of the photographic plates taken by the Harvard observatory party, at the Chosica station in Peru, Professor Pickering has announced the discovery of a long-period variable in Cælum of the same class as O Ceti, R Hydræ, and R Leonis. The spectra show bright hydrogen lines.

A number of other new variables have been detected in the examination of the photographic plates taken at the observatory, and have been announced by Professor Pickering in the Astronomische Nachrichten. Some attention has also been paid to this subject by Dr. J. C. Kapteyn in measuring the plates taken at the Cape of Good Hope for the formation of Dr. Gill's photographic *southern Durchmusterung*, and also by Mr. Roberts in the prosecution of his work in astronomical photography.

A general index to observations of variable stars, prepared under the direction of Prof. E. C. Pickering, forms No. 8 of Vol. 18 of the Harvard Annals. A large number of unpublished observations are referred to, particularly three extensive series of observations by Argelander, Heis, and Schmidt, to whose manuscripts access was given.

A new edition or rather revision of *Birmingham's Red Star Catalogue* has been printed in No. V of the Cunningham Memoirs of the Royal Irish Academy. The work of revision was undertaken by Rev. T. E. Espin in 1886, with the 17¼-inch equatorial reflector, and in the course of the work a number of new red stars, new variables, and stars with bright lines in their spectra were discovered. There is also an additional list of 629 "ruddy stars."

STELLAR SPECTRA.

Spectrum of ζ Ursæ Majoris.—Professor Pickering has reported a remarkably interesting peculiarity in the spectrum of this star. It was noticed that the K line was double in the photographs taken March 29, 1887, May 17, 1889, and August 27 and 28, 1889, while on many other dates the line appeared hazy as if the components were slightly separated, and at other times the line was well defined and single. It was concluded that the line was double at intervals of 52 days beginning March 27, 1887, and it was predicted that the doubling would occur again on December 9, 1889, and this prediction was confirmed by each of three photographs on the latter date. Professor Pickering says:

"The only satisfactory explanation of this phenomenon as yet proposed is that the brighter component of this star is itself a double star having components nearly equal in brightness and too close to have been separated as yet visually. Also that the time of revolution of the system is 104 days. When one component is approaching the earth all the lines in its spectrum will be moved toward the blue end, while all the lines in the spectrum of the other component will be moved by an equal amount in the opposite direction if their masses are equal. Each line will thus be separated into two. When the motion becomes perpendicular to the line of sight, the spectral lines recover their true wave-length and become single."

From the amount of separation of the lines Professor Pickering concludes that the relative velocity of the two components must be about 100 miles per second. If the orbit is circular and its plane passes through the sun, the distance traveled by one component, regarding the other as fixed, would be 900,000,000 miles, and the distance apart of the two components would be 143,000,000 miles, or about that of Mars and the sun. The combined mass would be about forty times that of the sun to give the required period.

Several other stars have been found from the Harvard photographs with a similar doubling of the lines, among them β Aurigæ and *b* Ophiuchi. For β Aurigæ Professor Pickering deduced a period of 4 days, and his results have been fully confirmed by observations made with quite different apparatus by Dr. Vogel at Potsdam.

A doubling of the K line in several photographs of the spectrum of Vega taken by Mr. A. Fowler, apparently indicating that Vega was a double star of the ζ Ursæ Majoris type, has not been confirmed by the photographs of Pickering, Vogel, and Henry.

The Henry Draper Memorial.—The third annual report of Professor Pickering announces the practical completion of two branches of the work undertaken, the photographic survey of the spectra of all stars north of — 25° declination having been effected on a twofold scale, the one survey including all stars brighter than the seventh magnitude, the other including stars two magnitudes fainter. The Bache 8-inch doublet employed in this work has been transferred to a station near Chosica in Peru and similar surveys for the stars down to the south pole have been commenced.

The fourth annual report of the Henry Draper Memorial contains as a frontis piece an engraving showing the periodical duplication of the K line in the spectrum of β Aurigæ, the study of which, with other similar cases has been the most important work of the 11-inch equatorial at Harvard. The spectroscopic survey of the brighter stars in the northern hemisphere (to — 25° declination) is nearly printed and the work on fainter stars is being satisfactorily pressed. Besides the spectra, charts of the entire sky are being formed with the same telescopes. A photographic map of the sky will thus be provided, approximately on the scale of the Durchmusterung, but including fainter stars; so far as it has been completed it has proved very convenient for studying suspected variables and in detecting errors in star catalogues.

Reference should also be made here to the lists of stars with peculiar spectra detected upon the Harvard Observatory photographic plates and published from time to time by Professor Pickering in the *Astronomische Nachrichten.*

A spectroscopic survey of the southern heavens by direct observation has been undertaken at the Melbourne Observatory. An 8-inch refracter and the 4-foot reflector will be used in the work.

MOTIONS OF STARS IN THE LINE OF SIGHT.

The following is a comparison of the results for motion in the line of sight obtained by Dr. Vogel at Potsdam with a photographic telescope, and those obtained by Maunder at the Greenwich Observatory by eye observations. The motions are given in geographical miles, + representing recession, and — approach:

	Vogel.	Maunder.
Capella	+17.1	+22.5
Aldebaran	+30.3	+31.6
α Persei	— 7.2	—22.5
Procyon	— 7.2	+ 3.8

Dr. Vogel's interesting results with regard to Algol and other stars have been alluded to elsewhere.

Bright lines in stellar spectra.—Mr. Espin has detected bright lines in the spectra of a number of variables when near their maxima, among them R Leonis, R Hydræ, χ Cygni, R Andromedæ, and S Cassiopeiæ all of Secchi's third type. Similar lines in the spectra of U and V Cygni, of the fourth type have been suspected by the Lick observers, and when these stars were far removed from their maxima. Mr. Keeler also finds that he is able to break up the apparently continuous spectra of stars of the type of the Wolf-Rayet stars in Cygnus into an extremely complicated range of absorption bands and faint bright lines.

A remarkable form of spectrum has been discovered by Professor Pickering in that of the star Pleione, for the F line consists in this case of a narrow bright line superposed on a broader dark line, the other hydrogen lines showing some indications of a similar character.

ASTRONOMICAL PHOTOGRAPHY.

The photographic chart of the heavens.—The permanent committee appointed by the Astrophotographic Congress at Paris, in 1887, as noted in the Review of Astronomy for the years 1887–88, held their first meeting at the Paris Observatory in September, 1890. The results of the seven séances are contained in a series of twenty-eight resolutions, some of the most important of which are mentioned below.

The zones were assigned to the several participating as follows:

NORTH.

	Latitude.		Zone.	
	°	′	°	°
Helsingfors	+60	9	+90 to	+70
Potsdam	52	22	70	58
Oxford	51	45	58	48
Greenwich	51	28	48	40
Paris	48	50	40	32
Vienna	48	13	32	24
Bordeaux	44	50	24	18
Toulouse	43	37	18	12
Catania	37	30	12	6
Algiers	36	48	+ 6 to	0
San Fernando	36	27	0 to	– 6
Chapultepec	19	26	– 6 to	–12
Tacubaya	+19	24	–12 to	–18

SOUTH.

Rio de Janeiro	–22	54	–18 to	–26
Santiago	–33	26	26	34
Sydney	–33	51	34	42
Cape of Good Hope	–33	56	42	52
La Plata	–34	55	52	70
Melbourne	–37	50	–70 to	–

No observatory in the United States appears on this list. A bill was introduced in Congress making an appropriation to enable the United States Naval Observatory to undertake a share of the work, but the bill failed to become a law.

The committee decided that the field of the telescope available for measurement should be 2° square; that the photographic plates employed (which are to be of plate glass) should be 160^{mm} (6¼ inches) square and the series of reference lines 130^{mm} (5⅛ inches) square with the lines 5^{mm} apart.

Twelve test objects were selected, all of which are situated near the equator, at intervals of about two hours of right ascension. In addition to these, the Pleiades, Præsepe, and a group in Cygnus were selected for the use of the more northern observatories.

To fix the time of exposure so that the plates shall contain stars to the eleventh magnitude, it was decided to determine first the time necessary to photograph a star of the 9.0 magnitude of Argelander's scale, and thereby multiplying by 6.25 the time of exposure for magnitude 11.0 will be obtained.

Three more numbers (3, 4, and 5) of the *Bulletin du Comité International permanent* pour l'Exécution Photographique de la Carte du Ciel have been published. Among the many papers contributed to these bulletins which have a very important bearing upon astronomical photography, may be mentioned one by Dr. Bakhuysen on the measurement of the plates by the method of rectangular coördinates, in which he obtains star-places comparing favorably with those from meridian observations. Dr. Vogel contributes one or two papers on the "réseaux" and the measurement of the plates, and Professor Kapteyn suggests the expediency of taking the catalogue plates with three exposures at intervals of six months, for the purpose of determining the stars' proper motions and parallaxes. Dr. Scheiner has an important paper on the application of photography to the determination of stellar magnitudes.

In the fifth number of the *Bulletin*, Professor Holden has two papers on the photographic magnitudes of stars, and Mr. Schaeberle one on the same subject. There is also an abstract of Dr. Lindemann's photometric determination of the star magnitudes of the Bonn Durchmusterung, and a paper by M. Trépied on the necessity of coming to some understanding as to what is meant by stars of the 9th, 11th, and 14th magnitudes on the photographic plates.

The question of the reproduction of the plates and of the publication of the map has been left open, but it is probable that one or more bureaus will be established for measuring the negatives obtained at observatories not provided with special apparatus for the purpose, and photographic copies of all plates will be preserved in selected places in case of accident to the original negatives.

A meeting of those interested in the various branches of astronomical photography other than the chart was called by Messrs. Janssen and Common in September, 1889. The chief matters for discussion being a complete photographic record of solar phenomena, including solar spectrum photography; a systematic description of the lunar surface by photography on a large scale; photographs of planets and their satellites, of comets, meteors, and particularly of nebulæ, clusters, and of stellar spectra.

In discussing the theory of the photography of a star projected upon a bright background, Professor Holden calls attention to the fact that the most important factor is the ratio of the focal length to the aperture of the objective; generally speaking it would be an advantage to diaphragm the objective during the day. This is also true with regard to ordinary observations during the day, a point of particular importance in connection with meridian observations.

Authoritative testimony as to the value of photography for obtaining accurate measures of star clusters is given by Dr. Elkin, who has compared Dr. Gould's reductions of Rutherfurd's photographs of the Pleiades taken over 20 years ago, with the heliometer measures made at Königsberg and New Haven. The smallness of the probable error Dr. Elkin regards as proof that in photography we have a means of investigation for micrometric work at least on a par with any existing method, and doubtless far surpassing the present methods in ease of measurement and output of work.

The Henry Brothers are reported to have made a decided advance in lunar photography in the plates taken with the equatorial of $0^{m}.32$ (12.6 inches) aperture intended for the chart work. The improvement is attributed especially to the process of enlargement employed, which makes the diameter of the moon about 1^{m} (39 inches). This photographic work is to be continued with the great equatorial coudé, which is soon to be mounted and provided with a photographic objective.

Mr. Roberts has devised a machine, which he calls a "pantograver," for measuring the magnitudes of the stars depicted upon the photographic plates and transferring them to metallic plates for printing.

COMETS.

The origin of comets.—Dr. Bredichin, the present director of the Pulkowa Observatory, who has devoted much time to the study of cometary phenomena, has expressed the opinion that periodic comets owe their origin to the segmentation of ordinary parabolic comets, having been thrown off from the latter by an eruption such as it is generally supposed we have witnessed in the great comet of 1882, and earlier in Biela's comet. Dr. Kreutz's monograph on this great September comet of 1882 forms one of the most important of recent contributions to cometary literature. The formidable obstacles to an accurate determination of its orbit presented by the disintegration of the nucleus into several points of condensation seem to have been most skillfully surmounted by the computer. His final value for the period of revolution is 772.2 years.

Dr. Holetschek claims that the systematic grouping of cometary perihelia in certain directions (270° and 90° of heliocentric longitude) has no connection with the general motion of the solar system in space, but is due to the position of the earth at the time that such discoveries are most readily made.

An important paper on the capture theory of comets will be found in the *Bulletin Astronomique* for June, 1889, and in the same journal for December, 1890, M. Tisserand has a further contribution to the same subject.

The *Observatory* for August, 1889, has a useful table of the approximate positions at the time of discovery of all comets seen since 1869, with brief notes on the physical appearance of each. Mr. Denning, who has compiled this table, proposes to supplement it by one with similar data for the comets from 1840 to 1868.

Brorsen's comet.—A careful search for Brorsen's comet, which passed perihelion in 1890, was made by Brooks and Swift, but without effect. This comet was discovered in 1846, and was last seen in 1879; it could not be seen at the return in 1884. Tempel's second comet, and Barnard's comet 1884 II, were also expected to return to perihelion in

1890, but were unfavorably situated for observation and escaped detection.

Comets of 1889 *and* 1890.—W. R. Brooks reported the discovery, on the morning of January 15, 1889, of a faint comet in Sagittarius, and to it the designation Comet *a* 1889 was given, as the first comet discovered during the year. A careful search for the object was made by a number of observers, especially by Barnard and Swift, but without success. As the three observations necessary for determining the orbit were not secured, the comet is not catalogued with those of the year. A comet announced by Swift on July 15, 1889, is also omitted, as it proved to be identical with the comet discovered by Brooks on August 7, 1888. (1888 III).

A phenomenon reported at Grahamstown, South Africa, on the 27th of October, 1890, should be mentioned in connection with the notes on comets. It was described as a bright band one-fourth of a degree wide and 30° longitude, afterwards increasing to 90°. At one end it looked like the head of a comet, while the other end faded out gradually. Its motion was extraordinary, as it swept over more than 100° in less than 1^h 15^m.

The comets for the years 1889 and 1890, with their final designations, in the order of perihelion passage are as follows:

Comet 1889 I:
= Comet *e* 1888.

The first comet of 1889, in the order of perihelion passage, was that discovered by Barnard at the Lick Observatory with a 4-inch comet-seeker on September 2, 1888, or the morning of September 3. It was also independently discovered by Brooks, at Geneva, New York, on the following morning. At the end of November, and as late as January 4, 1889, it was visible to the naked eye. Perihelion was passed on January 31, 1889, and by that time, the comet disappeared in the sun's rays. The first observations after conjunction were made about May 24, and it was followed till its light was again overpowered by that of the sun, late in October, 1889, its appearance being about the same as before perihelion, small, round, quite bright, and with a short tail. The orbit seems to be hyperbolic.

Barnard remarked on June 3 that there was an anomalous tail directly following the comet, about 1° in length and some 2′ or 3′ broad, a phenomenon which, according to Bredichin, was probably an effect of perspective.

The comet was observed again at the Lick Observatory by Barnard August 17, 1890, although its distances from the earth and sun were then, respectively, 6.0 and 6.5 in terms of the earth's mean distance. The later observations confirm the hyperbolic character of the orbit.

Comet 1889 II:
= Comet *b* 1889.

On the evening of March 31, 1889, E. E. Barnard discovered, with the 12-inch equatorial of the Lick Observatory, a very small and slender comet, with a tail 15′ long. By the end of April it was lost in the evening twilight, reappearing again, with extremely slow geocentric motion, about July 25, and remaining visible to November 21. The great perihelion distance of this comet is especially noteworthy, amounting to $2\frac{1}{4}$ times the distance of the earth from the sun, a distance which seems to have been surpassed in the catalogue of comets only by comet 1885 II, with a perihelion of $2\frac{1}{2}$, and the comet of 1729, with perihelion distance 4.

Comet 1889 III:
= Comet *c* 1889.

Mr. Barnard discovered another comet at about 2 o'clock on the morning of June 24, in the constellation Andromeda. At the time of discovery the comet was only three days past perihelion. It was then very faint and rapidly became still fainter, being last observed on August 6. The elements computed by Berberich show considerable ellipticity in the orbit, the period of revolution being 128 years.

Comet 1889 IV:
= Comet *e* 1889.

A tolerably bright comet was discovered with the naked eye by Mr. J. Ewen Davidson at Branscombe, Mackay, Queensland (latitude − 21° 9′ south), on July 19. It had a sharp, stellar nucleus, and a tail 30′ long; in a photograph taken by Barnard at the Lick Observatory on July 30, the tail could be followed still farther, to a distance of almost 1° from the head. A second tail was reported by Kammermann, of Geneva, on the 17th of August, and a segmentation of the nucleus by Riccò about a week earlier.

Professor Holden finds that the brightest part of the tail was $\frac{1}{400}$ of the brightness of the brightest part of the solar corona during the eclipse of January 1, 1889, and $\frac{1}{8000000}$ that of the full moon.

The comet was followed in the northern hemisphere to about the end of the year.

The spectrum according to the Lick and Palermo observations in July and August showed no peculiarity; the carbon bands, and the continuous spectrum of the nucleus, alone being recorded.

Comet 1889 V:
= Comet *d* 1889.

William R. Brooks, of Geneva, New York, while sweeping in the southwestern sky on the morning of July 6, 1889, detected a suspicious looking nebulous object, the cometary character of which he was able to confirm on the following morning; it was then faint, of about 11th magnitude, a diameter of 1′, stellar nucleus, and tail 10′ long. The comet attracted no especial attention from astronomers till August 1, when Barnard discovered that it had two small and nebulous companions, and on the morning following it was evident that these two objects were moving with the parent comet through space. Mr. Barnard says:

"On August 3 they were examined with the 36-inch equatorial, which showed the whole group very beautifully. Each of the companions had a very small nucleus and condensation in a very small head and a short faint tail, presenting a perfect miniature of the larger one, which was pretty bright and well developed, with small nucleus and slightly fan-shaped tail $\frac{1}{4}$° long. There was then absolutely no nebulous connection with the larger, nor has there been at any time since, either in the 12-inch or in the 36-inch telescope. Nothing whatever has been seen here of the nebulous envelope spoken of by the Vienna observers as apparently inclosing the whole group (A. N., 2914). I have from the first carefully looked for a nebulous connection. Under unfavorable circumstances the tails of B and C might be imagined to be a connecting nebulosity, but the tail of B falls short of A, and that of C does not nearly reach B. Each comet is in appearance absolutely independent of the other. The tails of all three have lain in the line of the nucleus of A, and therefore have not sensibly deviated, from the position-angle 241°."

"On August 4, two other companions were detected with the great telescope, one of which was measured, the other being too elusive to set the wire on. I have numbered these four companions B, C, D, E, in the order of increasing right ascension, A being the larger comet, D and E being the two last discovered. D has been seen several times since the moon withdrew, but has always been too faint to observe. It has not sensibly changed its position. E has only been seen once. Its position angle referred to C would be the same as that of D, and its distance twice as great. Four or five other nebulous bodies observed near the comet, August 2, have not since been seen, and were probably nebulous.

"The results of the observations of the two brighter companions are extremely interesting. Measures of B have been made on eighteen, and of C on seventeen nights. These two have almost exactly the same position-angles, which have been sensibly constant. Their distances from the main body have, however, been increasing. At the last observations, B seems to be stationary, the distance from A remaining constant, while C continues to recede."

Mr. Chandler's investigation of the orbit of this comet has developed a strong probability that it is identical with a comet discovered by Messier in 1770, often called Lexell's lost comet, because that astronomer calculated that it was moving in an elliptic orbit with a period of about 5½ years, though it was not seen afterwards. It is now well known that this was due to the fact that at the return in 1776 its position was such as to render any observation impossible, and before another return could take place the comet made in 1779 so close an approach to the planet Jupiter as completely to change the nature of the orbit. Mr. Chandler finds that Brooks's comet also made a near approach to Jupiter, so near, in fact, on May 20, 1886, that it was only about nine diameters of Jupiter distant, or only a little outside the orbit of his third satellite. Calculation of the elements of the comet orbit before this appulse leads to the conclusion that they present a great similarity to those of Lexell's comet after its approach to the planet in 1779, rendering the probability great that the bodies are identical. Mr. Chandler shows that no similar serious disturbance will occur again until 1921, so that appearances may be looked for in 1896, 1903, 1910, and 1917, at each of which return the condition of visibility will be favorable, giving opportunities for further investigations into the motions of this interesting comet, which, it appears, narrowly escaped being converted into a fifth satellite of Jupiter. Mr. Barnard succeeded in finding and observing the comet again, on the night of November 21, 1890, with the 36-inch Lick telescope, eight months after it had been given up as beyond reach; and when its distance from the earth was 3.09, and from the sun 3.55.

Comet 1889 VI:
=Comet *f* 1889.

Swift, at Rochester, discovered a new comet on November 16, while searching for new nebulæ; it was a faint round nebulous mass, without tail, and it remained exceedingly faint during its entire period of visibility; being seen in only the most powerful telescopes about the middle of January. The orbit proved to be elliptical, and with the remarkably short period of 8.8 years, according to Searle's computation.

Comet 1890 I:
=Comet *g* 1889.

A faint comet was discovered by Borelly at the Marseilles Observatory on December 12, 1889, this being the first comet, after an interval of three years, discovered in Europe. On January 8, 1890, it appeared in the finder of the Munich refractor like a faint star of the seventh or eighth magnitude.

Comet 1890 II:
= Comet *a* 1890.

Discovered by W. R. Brooks at the Smith Observatory, Geneva, New York, March 19, 1890. A small comet with stellar nucleus and short tail. It was still observable about the middle of October.

Comet 1890 III:
= Comet *b* 1890.

Discovered by Coggia at the Marseilles Observatory, July 18, 1890. It was quite bright, round, with central condensation comparable with a star of about tenth or eleventh magnitude. Its light rapidly diminished and it soon disappeared below the northwest horizon. Parabolic elements represent the observations quite accurately, though they show some resemblance to those of the comet of 1580.

Comet 1890 IV:
= Comet *e* 1890.

This comet was discovered three months and a half after perihelion passage by Zona at Palermo, November 15, 1890. It was at first quite bright, but grew fainter rapidly, though it was still observed after the close of the year.

Comet 1890 V:
= Comet *d* 1890.
= d'Arrest's comet.

An ephemeris for d'Arrest's periodic comet had been prepared by Leveau, and the comet was looked for without success for some time, and it was feared that it had gone by undetected, when it was picked up by Barnard at the Lick Observatory on October 6, as an entirely unexpected object. On the first few nights the comet was extremely faint and diffused, but it was seen later with a 3¼-inch finder.

Comet 1890 VI:
= Comet *c* 1890.

Discovered by W. F. Denning at Bristol, England, July 23, with a 10-inch reflector, a faint, round nebulosity, about 1′ diameter with faint central condensation, and quite near ϑ and ζ Ursæ Minoris. It moved directly towards the equator, and was visible till November, having a small stellar nucleus of the thirteenth magnitude, and a faint diffused tail.

Comet 1890 VII:
= Comet *f* 1890.

This comet, the most interesting perhaps of those found during the year, on account of its short period, was discovered by R. Spitaler at Vienna, November 16, 1890.

Dr. Spitaler, in looking for the comet discovered by Zona, turned the 27-inch telescope towards the place which it should occupy, according to the dispatch received by him, and immediately perceived a very faint comet, but concluding from the description that Zona's was brighter, by turning the telescope a little he found the latter, physical connection between the two being excluded by the slower motion of his own. The period appears to be about 6.4 years.

Approximate elements of the comets of 1889 and 1890. *

Designation.	Perihelion=T Greenwich mean time.	Ω	ω	i	q	e
	1889.	° ′	° ′	° ′		
1889 I	Jan. 31.21	357 25	340 29	166 22	1.815	....
II	June 10.82	310 42	236 6	163 51	2.256	....
III	June 20.78	270 58	60 8	31 13	1.110	0.957
IV	July 19.27	286 11	345 52	65 57	1.040	....
V	Sept. 30.01	17 58	343 28	6 4	1.950	....
VI	Nov. 29.82	330 25	70 1	10 15	1.354	0.683
1890 I	Jan. 26.48	8 29	199 52	56 45	0.270	....
II	June 1.47	320 21	68 54	120 34	1.908	....
III	July 8.65	14 25	85 53	63 15	0.766	....
IV	Aug. 7.09	85 23	331 19	154 18	2.047	....
V	Sept. 16.	146 5	172 58	15 43	....	0.627
VI	Sept. 24.48	100 7	163 0	98 56	1.260	....
VII	Oct. 26.56	45 6	12 51	12 51	1.818	0.472

Designation.	Discoverer.	Date of discovery.	Synonym.	Remarks.
		1888,'9.		
1889 I	Barnard	Sept. 2	1888 *e*	
II	do	Mar. 31	1889 *b*	
III	do	June 23	1889 *c*	Elliptic?
IV	Davidson	July 21	1889 *e*	
V	Brooks	July 6	1889 *d*	Lexell's?
VI	Swift	Nov. 17	1889 *f*	
1890 I	Borrelly	Dec. 12	1889 *g*	
		1890.		
II	Brooks	Mar. 19	1890 *a*	
III	Coggia	July 18	1890 *b*	
IV	Zona	Nov. 15	1890 *e*	
V	Barnard	Oct. 6	1890 *d*	d'Arrest's.
VI	Denning	July 23	1890 *c*	
VII	Spitaler	Nov. 16	1890 *f*	Period 6.4 years.

* See Astronomical Journal, Nos. 212 and 238.

METEORS.

A valuable résumé of meteoric astronomy has been published by Prof. J. R. Eastman in the Bulletin of the Philosophical Society of Washington. (Vol. XI.) Abstracts of the various theories propounded in explanation of meteors are given, and extensive catalogues of observed meteors and meteorites.

Mr. Denning pointed out several years ago that there were a number of meteor streams in which the meteors seemed to radiate from the same point in the sky for a period of three months or more. The only explanation of this phenomenon seemed to be that the meteors were moving with frightful velocity through space, but M. Tisserand, from a mathematical study of the problem, shows that these meteors do not all come from the same stream; they may perhaps belong to a family presenting certain common characteristics, but they are in reality different streams accidentally falling together, a not very improbable assumption considering the great number of meteor streams and the difficulty of determining the radiant with any degree of precision.

Mr. Denning does not, however, admit that an accidental coincidence of radiant points of different streams is a sufficient explanation of the phenomena he has observed.

THE ZODIACAL LIGHT.—Prof. Arthur Searle, who has made a special study of the zodiacal light, finds that the permanence of the ordinary western light, subject only to slight variations in the degree of visibility, is confirmed by the observations of the last 50 years at the Hanaud Observatory. The zodiacal bands, which are said to form a prolongation of the ordinary zodiacal light, were not seen, though stellar or nebulous bands, one extending from Aquila to the Pleiades, and the second from Præsepe to Coma Berenices have been noticed and perhaps offer an explanation of the zodiacal bands. The Gegenschein, it is suggested, may be due to a maximum of light reflected from the meteoric matter scattered in the solar system.

The observations of Prof. C. Michi Smith, carried on at intervals since 1875 indicate a periodic appearance of the line at wave-length 558 in the zodiacal light spectrum; a line differing but little in wave-length from the auroral line (wave-length 556.7).

PLANETS.

A very laborious work is being carried on in the office of the American Ephemeris, under the superintendence of Professor Newcomb—the re-determination of the elements of all the larger planets. Professor Newcomb's plan includes the re-reduction of the older planetary observations and the discussion of the later ones, with a view of reducing them all to a uniform system. Another branch of this planetary work is a determination of the mass of Jupiter from the motions of Polyhymnia, and a comparison of Hansen's tables of the moon with observed occultations since 1750.

The first volume of this series of memoirs upon the theories of the major planets has appeared in the "Astronomical Papers," of the American ephemeris, being a new discussion of Jupiter and Saturn by Hill. He has determined the complete analytical expressions for the coördinates of these two planets, giving also a provisional comparison of his theory with observations. The method followed is in general that of Hansen.

In commenting upon recent determinations of planetary masses from the motions of comets, Professor Hall says:

"The objection to deducing values of planetary masses from the motions of comets consists, I think, in the fact that apparently other forces than that of gravitation act on these bodies. As a comet approaches the sun it changes form, disintegrates, and matter is thrown off to form a tail. Until we know more of the theory of these changes the computation of masses from the motions of comets and inferences about the resisting medium in space must be uncertain."

MERCURY.—The observations of Schroter early in the present century indicated that Mercury had a motion of rotation about its axis of about 24 hours. Subsequent observers failed, however, to confirm his observations, and the question of Mercury's rotation has generally been regarded as one of the unsettled problems of astronomy. M. Schiaparelli, taking advantage of the clear sky of Milan, has observed Mercury since 1881, obtaining about one hundred and fifty sketches, showing quite well-marked spots, from which he has deduced a rotation period of 88 days, the same, in fact, as the period of rotation of the planet around the sun. Schiaparelli also concludes that the axis of rotation must be nearly perpendicular to the orbit of the planet, the rotation being uniform.

Dr. von Hærdtl has obtained the following values for the mass of Mercury:

I. Mass of Mercury, 1 : 5,012,842 from Winnecke's comet.
II. Mass of Mercury, 1 : 5,514,700 Le Verrier's equation modified.
III. Mass of Mercury, 1 : 5,648,600 Encke's comet, 1819–1868.
IV. Mass of Mercury, 1 : 5,669,700 Encke's comet, 1871–1885.

VENUS.—Schiaparelli has concluded, from an exhaustive rediscussion of all the older observations, combined with his own observations of 1877 and 1878, that Venus rotates upon its axis in 225 days, or the same time that it rotates about the sun, contrary to the generally received hypothesis that its rotation period is about 23 hours. Venus, then, as well as Mercury, would seem to turn always the same face to the sun, as the moon turns the same face to the earth.

THE EARTH—*Variation of latitude.*—The subject of the change of terrestrial latitudes, to which allusion has been made in previous reports, continues to receive considerable attention from astronomers and geographers. The following results have been obtained by Dr. Küstner, in continuation of his former researches, from 7 pairs of stars at three different times of the year:

Epoch.	Latitude of Berlin.
1884.32	+52° 30′ 16″.73−0.82 ⊿ A
1884.70	16″.96+0.83 ⊿ A
1885.31	16″.52−0.85 ⊿ A

where Δ A represents the correction to the assumed constant of aberration. The direct inference from these figures is that in 7 months the latitude of Berlin decreased 0″.44. Pulkowa showed about the same time a similar change:

Epoch.	Latitude of Pulkowa
1882.31	+59° 46′ 18″.52
1883.51	18″.54
1884.70	18″.63
1885.23	18″.31
1885.31	18″.30

a decrease of 0″.33 from 1884.70 to 1885.31.

The general agreement of these results certainly calls for further investigation; and to test the matter Mr. Preston has been sent out by the U. S. Coast Survey, and Dr. Marcuse by the International Geodetic Commission, to Honolulu, which is at the opposite end of the earth's diameter from Berlin, and by simultaneous observations at these two stations it is hoped the question will be settled.

It is quite possible that the origin of the apparent change at Berlin in 1884–1885 is meteorological, a view to which Dr. Foerster inclined in bringing the matter before the Association Géodésique in 1888. The whole question is, then, whether there are changes in the disposition of atmospheric strata sufficient to account for the facts observed, or the axis of rotation and the axis of inertia of the earth are not sensibly coincident.

A complete résumé of the subject is given by M. Tisserand in the *Bulletin Astronomique* for September, 1890.

Mr. Riccò has experimented with a somewhat novel demonstration of the rotundity of the earth. At the observatory of Palermo, which is situated at a distance of 1¼ miles from the Mediterranean and 236 feet above its level, a great number of photographs of the sun reflected from the surface of the water have been taken a few minutes after rising or before setting, and they show that the diameter in the plane of reflection is less in the reflected image than in the direct. This deformation is due to the fact that the surface of the water forms a cylindrical mirror, with axis horizontal and normal to the plane of reflection. The amount of the observed flattening accords well with that demanded by theory.

Standard time.—The introduction of the system of standard time, which has been found of such practical usefulness in the United States, has been quietly agitated in other countries for several years past, and a well-written article upon the subject by Dr. Robert Schram will be found in the *Observatory* for April, 1890. The adoption of a uniform time system, the time of the fifteenth meridian east of Greenwich, has been very favorably looked upon in Austria and Germany for railroad purposes.

Of the proposed change of the beginning of the astronomical day from midday to the preceding midnight nothing has been heard since the original agitation of the subject at the time of the Meridian Conference at Washington in 1884.

The moon's physical libration.—Dr. Julius Franz of the Königsberg observatory has done an excellent piece of work in bringing to light and discussing (vol. 38, Königsberg Beobachtungen) the observations of the moon made by Schlüter, an assistant of Bessel's, in 1841–1843, the work having been undertaken by Schlüter under the immediate supervision of his distinguished chief. The observations were continued by Wichmann after Schlüter's death, but Wichmann was never able to do more than to reduce his own observations for preliminary results to be used in a discussion of all the material available.

Dr. Franz recommends the substitution of observations of the spot Mösting A for those of the limbs, in determining the moon's place, a method upon which a report was published by the late Dr. C. H. F. Peters in the U. S. Coast Survey volume for 1856.

Temperature of the moon.—A memoir on the temperature of the moon by Mr. S. P. Langley forms a part of the fourth volume of the publications of the National Academy of Sciences, and is re-published in a somewhat abbreviated form in the *American Journal of Science* for December, 1889. The paper may be regarded as the completion of a piece of work commenced in 1883, and represented by papers read in 1884 and 1886, as well as the present one. The principal conclusion drawn is "that the mean temperature of the sunlit lunar soil is much lower than has been supposed, and is most probably not greatly above zero centigrade." The principle by which this temperature is estimated is that the position of the maximum in a curve, representing invisible radiant heat of different wave-lengths, furnishes a criterion as to the temperature of the radiating solid body. In the lunar spectrum two distinct heat maxima are found—one corresponding to radiation reflected from the soil, the other to that emitted by it (when warmed by sunshine). The determination of the second maximum with accuracy would give an accurate value for the temperature of the sunlit soil; but, unfortunately, the absorption-bands produced by the earth's atmosphere obscure this maximum, and render the conclusions somewhat uncertain; so that Professor Langley is compelled to state his principal conclusion in a guarded manner, as above quoted.

The Proceedings of the American Academy of Arts and Sciences (vol. 24) contains an account of some measures of lunar radiation made by Mr. C. C. Hutchins, by means of a new thermograph which he has devised. This instrument consists of a single thermal junction of nickel and iron placed in the focus of a small concave mirror, and is found to be much more sensitive than a thermopile of forty-eight couples. The measures of lunar radiation were made with an arrangement similar to that of a Herschel's telescope with the thermograph in place of an eye piece, the conclusion reached being that the heat which the earth receives from the moon is to that from the sun as 1 is to 184,560. From observations during the eclipse of January 28, 1888, Mr. Hutchins infers that all but a minute portion of the rays from the lunar soil and rock are cut off by our atmosphere, as it seems impossible that a surface like that of the moon, upon which the sun has been shining for many days, should suddenly cease to radiate when the sun's light is withdrawn.

MARS.—Durin gthe opposition of 1890 Mars again received special attention from the Lick observers. Experiments were tried with colored glasses, with diminished apertures, etc., all with small success. Many photographs were also secured, but none that were pronounced satisfactory. The mystery of the "canals" is still further increased by the fact that while Professor Holden and Mr. Keeler always saw the canals as dark, broad, somewhat diffused bands, and Mr. Schaeberle saw them in the same way when the seeing was bad, but under good conditions described them as narrow lines a second of arc or so in width. On April 12 Mr. Schaeberle saw two of the canals doubled, thereby verifying Professor Schiaparelli's observations. The positions of most of the canals have also been verified by some of the Lick astronomers.

JUPITER.—Mr. J. E. Keeler publishes in the monthly notices for November a drawing of Jupiter made with the Lick 36-inch on the night of August 28, 1890. The great red spot is described as being of about the same dimensions as in 1889, with a dark shading at its following end, but the middle whiter and the arrangement of belts somewhat different. "It would seem, on the whole, that the surface features of Jupiter indicate less activity in the internal forces of the planet than was manifest a year ago."

Barnard and Burnham have reported a very curious doubling of the first satellite as seen with the 12-inch equatorial of the Lick observatory. Of this phenomenon there seems to be but two possible explanations: either there is a white belt on the satellite parallel to the belts of Jupiter or the satellite is actually double.

M. Belopolsky has brought out from an examination of drawings of Jupiter a peculiar variation in the time of rotation (first noted by Cassini) with the latitude. A velocity of $9^h\ 51^m$ was found in the zone 0° to 5° in both hemispheres, and a time of rotation of $9^h\ 55.5^m$ for the remainder of the surface, both hemispheres, except between 5° and 10° of north and south latitude, where the two velocities appear to occur with equal frequency.

SATURN.—A peculiar white spot on the rings of Saturn attracted considerable attention in the early part of 1889. This spot was first seen by Dr. Terby, of Louvain, on March 6, 1889, who reported it as adjacent to the shadow of the ball and similar to the white spots sometimes seen upon Jupiter; on March 12 it was again seen with an 8 inch Clark telescope, but on the 15th, 20th, 22d, and 23d, and on April 2, it was invisible. While several observers confirmed Dr. Terby's discovery, nothing to correspond sufficiently with his description could be made out by others, though provided with much more powerful apparatus. Professor Hall has expressed the opinion that it was an optical effect of contrast.

The very fine division of the outer ring detected with the 36-inch Lick refractor early in 1888 was again seen in 1889 at a distance of about one-sixth of the breadth of ring A from its outer edge. A dark shading extended inwards from the new division almost to the inner edge of the ring. Professor Holden has noted also an extremely narrow brighter polar cap about 5 seconds of arc wide, in a direction parallel to the equator, and perpendicular to this about the width of the Cassini division at the ansæ.

An interesting monograph on Saturn, the result of fourteen years work, is contributed by Prof. Asaph Hall as Appendix II to the Washington Observations, 1885. The characteristic of this memoir is great caution, and the three drawings of the planet, where a few scanty markings represent all that Professor Hall can certainly see with a fine telescope, should re-assure those who have been dissatisfied with their modest instruments because they could not therewith recognize the elaborate detail described by more imaginative observers. To quote the author's own words: "The appearance of Saturn in our 26-inch refractor undergoes great changes from night to night, and sometimes even from hour to hour during the same night. Probably these changes are due to variations in our own atmosphere and in the action of the objective, and they do not therefore indicate real changes in the planet. Whenever we have a steady and transparent atmosphere, the outlines of the planet, the faint belts and markings on the ball, the shadow of the ball on the ring, the dusky ring, and the Cassini division are clear and distinct, and the abnormal phenomena sometimes seen are not visible. Without exception, my experience is that on good nights the planet always has this natural appearance. But on poor nights, when the image is blazing and unsteady, one can see and imagine many strange things about this wonderful object."

Professor Hall finds for the rotation period of the planet from observations of the white spot (1876, December 7 to 1877, January 2) $10^h\ 14^m\ 23^s.8 \pm 2^s.3$ mean time (see Astron. Nachr. No. 2146). Careful discussions are also given of the position and dimensions of the ring.

The notch in the outline of the shadow was never seen at Washington, either by Professor Hall or his assistant. "The curvature of the outline of the shadow presented an anomaly in 1876 when the convexity appeared to be turned towards the ball, contrary to what we should expect from geometrical considerations. The notes show that something of this kind was seen after the re-appearance of the ring in 1878. After the ring was well opened, the curvature of the outline always appeared natural or turned away from the ball." (*Observatory.*)

The last determination of the thickness of Saturn's ring, as Professor Hall has pointed out, was made in 1848 by W. C. Bond, who found that it was less than 0.″01; Duséjour estimated its thickness at 0.″2, and Schroeter at 0.″13. At the disappearance of the ring in September and October, 1891, the conditions of observation are not very favorable, a better opportunity occurring in 1892.

In connection with the approaching disappearance of the ring, an account of observations made by M. E. L. Trouvelot upon the passage of the sun and earth through the plane of the rings in 1877–'78 is of especial interest.

Saturn's satellites.—Dr. Hermann Struve has published the second installment of his work on the theory of Saturn's satellites. In this he discusses the orbits of Mimas and Enceladus, and their connection with the other satellites, and he has been able to account satisfactorily for the large corrections to the computed position of Mimas required during the past few years. In his previous paper Dr. Struve was led to assume a sensible mass for the ring-system of Saturn, but he now concludes that this hypothesis must be rejected, the mass of the ring being so small that the terms to which it would independently give rise in the disturbing function are as yet undetected by observation.

A determination of the orbit of Titan and the mass of Saturn, the result of several years' work with the Yale observatory heliometer, is published by Mr. Asaph Hall, jr., in the Transactions of the Yale Observatory, 1889. His value for Saturn's mass is 1:3500.5 ± 1.44, agreeing well with Bessel's value 1 : 3502, and that obtained by Struve 1:3498.

URANUS.—Dr. Huggins has found evidence of solar lines in the photographic spectrum of Uranus, with an exposure of two hours (June 3, 1889). All the principal solar lines were seen, but no others either bright or dark. Mr. Taylor, on the other hand, has reported bright flutings seen with a direct vision spectroscope attached to the five-foot reflecter of Common's observatory, Ealing, and if this observation is confirmed it will of course prove that the planet is at least in part self-luminous.

THE MINOR PLANETS.

The discovery of additional members of the zone of asteroids goes on without the least signs of abatement, and the number has now reached 301, no fewer than 6 having been found in 1889, and 14 in 1890. Twice during 1890 (April 25 and September 9) two were discovered on the same evening by the same observer; and the two discovered by Palisa on April 25 were independently discovered by Charlois on the following evening, April 26.

List of minor planets discovered in 1889 and 1890.

Number.	Name.	Discoverer.	Date of discovery.
			1889.
282	Clorinda	Charlois, at Nice	Jan. 28.
283	Emma	do	Feb. 8.
284	Amelia	do	May 29.
285	Regina	Palisa, at Vienna	Aug. 3.
286		Charlois, at Nice	Do.
287	Nephthys	Peters, at Clinton	Aug. 25.
			1890.
288	Glauke	R. Luther, at Düsseldorf	Feb. 20.
289	Nenetta	Charlois, at Nice	Mar. 10.
290	Bruna	Palisa, at Vienna	Mar. 20.
291	Alice	do	Apr. 25.
292	Ludovica	do	Do.
293	Brasilia	Charlois, at Nice	May 20.
294	Félicia	do	July 15.
295	Theresia	Palisa, at Vienna	Aug. 17.
296		Charlois, at Nice	Aug. 19.
297		do	Sept. 9.
298		do	Do.
299		Palisa, at Vienna	Oct. 6.
300		Charlois, at Nice	Oct. 3.
301		Palisa, at Vienna	Nov. 16.

An asteroid discovered by Charlois, November 14, 1890, and supposed by him to be 298 (discovered September 9), proved to be not identical with the latter. Consequently it takes the number 302.

SOLAR SYSTEM.

Prof. Lewis Boss has made a new determination of the amount and direction of the solar motion based upon a list of 253 stellar proper motions derived from the Albany zone observations. Professor Boss considers, as the most probable result from these data, that the apex of the sun's way is in right ascension $18^h\ 40^m$; declination $+40°$, or not far from the star Vega.

Herr Oscar Stumpe, of Borm, has made a new determination of the direction of the solar motion from the proper motions of 1,054 stars, which he divides into four groups, according to the magnitudes of their proper motions in a great circle. He thus obtains four different values of the apex of the sun's way, all agreeing in locating that point in the constellation Lyra, or in the adjacent part of Cygnus.

Prof. J. R. Eastman, in an address as president of the Philosphical Society of Washington, has given an analysis of the investigations to determine the apex of the sun's motion and its velocity of translation. He shows that, contrary to the ordinarily accepted belief, faint stars are nearer us than bright stars; a result also shown by the list of stellar parallaxes recently published by Oudemans.

SUN.

Rotation of the sun.—Mr. Crew, whose observations of the rotation of the sun were noted in a previous summary, has made a new series of observations for the correction or confirmation of his conclusion that the angular velocity of rotation increased with an increase of latitude. He still finds shorter rotation periods for the higher latitudes, the mean value for the period at latitude 45° being 18 hours shorter than at the equator, though owing to the smallness of this amount and the uncertainty of the observations he is of the opinion that "no certain variation of period with latitude has been detected with the spectroscope." Attention is called however to the wide differences of the equatorial period as obtained by different methods, differences which may be due to the fact that we are really dealing with different strata of the sun, though here also much reliance must not be placed upon the observations.

Spectroscopic observations made by Dunér for determining the rotation time of the sun, confirm the slowing down of the time of rotation with an increase of heliocentric latititude, quite contrary to the result recently obtained by Wilsing. A period of 25.46 days is deduced for the sidereal rotation at the equator, and 38.54 days for that at latitude 74.8°.

Diameter of the sun.—Dr. Auwers discusses, in the third memoir on the diameter of the sun, communicated to the Berlin Academy, the observations at Greenwich by Maskelyne and his assistants from 1765 to 1810. Curious differences of personal equation between different observers are brought out. Instead of Maskelyne's observations giving progressively smaller values of the sun's diameter during his whole observing life, as has hitherto been supposed, Dr. Auwers's very exhaustive discussion indicates that after the first two years (which gave a very large value) the observed diameter remained nearly constant for the period 1767–1772, then during the years 1772–1790 the diameter was continually decreasing, lastly from 1790–1810 the observations gave a diameter continually increasing. The minimum value in 1790 was 31′ 58″.13—about 1″ smaller than the value obtained from modern heliometer measures.

Spoerer's researches on sun spots.—Professor Spoerer, who has devoted much attention not only to the current state of the solar activity, but also to the early records of sun spots, published early in 1889 two important papers on the results of his researches in the latter field. The two papers are entitled respectively, *Ueber die Periodicität der Sonnenflecken seit dem Jahre* 1618, communicated to the Royal Leopold-Caroline Academy, and *Sur les différences que présentent l'hémisphère nord et l'hémisphère sud du Soleil*, appearing in the number of *Bulletin Astronomique* for February, 1889. The conclusions arrived at in these two papers may be summarized under the three following heads:

First: These earlier observations afford us many examples of the operation of the "law of zones;" that is to say, a little before a minimum spots are only seen in low latitudes, at about the time of minimum spots near the equator cease to appear, while a fresh series of spots break out a great distance from it, and thenceforward to the next minimum the mean heliographic latitude of the spots tends to decline continuously, until at length spots are again seen only in the vicinity of the equator. This law held good, Professor Spoerer shows, for the minima of 1619, 1755, 1775, 1784, 1833, and 1844, and to some extent for that of 1645.

Second: Though in general a predominance of spots for a time in one hemisphere is sooner or later balanced by a corresponding predominance in the other, this is not always the case, and Professor Spoerer calls attention to three periods in which the southern hemisphere was decidedly the more prolific. The first was from 1621 to 1625, there being no northern spots in 1621 and 1622, and but few in the three following years. Another is the present period, for from 1883 to the present time the southern spots have been nearly twice as numerous as the northern. But the third was the most remarkable, for from 1672 to 1704 we have no record of any northern spots at all; and Cassini and Maraldi expressly declared, on the appearance of a northern spot in 1705, that they did not recollect ever to have observed a spot in that hemisphere before. Northern spots continued to be infrequent until 1714.

Third: For a period of about seventy years, ending in 1716, there seems to have been a very remarkable interruption of the ordinary course of the spot cycle. In several years no spots appear to have been seen at all, and in 1705 it was recorded as a most remarkable event that two spots were seen on the sun at the same time, for a similar circumstance had scarcely ever been seen during the sixty years previous. So far as the observations go, the "law of zones" also seems to have been in abeyance, for no regular drift was apparent, the mean latitude being low—about 8° or 9°—during the entire time.

Professor Spoerer is still continuing his researches into ancient sun-spot records, and hopes to be able to examine the manuscripts of Plantade (1705–1726) and of Flaugergues (1794–1830). (E. W. M. *Monthly Notices* R. A. S., February, 1890).

Attention should be directed to a paper in the Monthly Notices for December, 1890, by Rev. A. L. Cortie, S. J., on the sun-spot observations made at Stonyhurst in the years 1882–'89.

A comparison of sun-spot statistics for 1878 with the records of 1889 gives a sun-spot period of exactly 11 years, and it seems probable that the real minimum occurred about the end of 1889. This probability is increased by the appearance on March 4, 1890, of a large spot in heliographic latitude +34°, which during its period of visibility in a semi-rotation of the sun passed within one-sixth of the sun's diameter from its northern edge. During the whole of the year 1889 the southern hemisphere of the sun manifested greater activity than the northern;

protuberances were seen, according to Tacchini, in both hemispheres at high latitudes where there were neither spots nor faculæ; there were also zones with spots and without faculæ.

Mr. Lockyer has presented a second report to the Solar Physics committee on the observations of sun-spot spectra made at South Kensington. He finds that the observations (to February, 1888) confirm the conclusion which he arrived at in 1886, that "as we pass from minimum to maximum the lines of the chemical elements gradually disappear from among those most widened, their places being taken by lines of which we have at present no terrestrial representatives.

SOLAR SPECTRUM.

Thollon's chart of the solar spectrum.—In 1879 Thollon presented to the Académie des Sciences a map of the solar spectrum, extending from A to H, made with his great spectroscope. His work was renewed with more perfect apparatus, but on account of the great labor of the undertaking he confined himself to the region from A to *b;* this was presented to the Academy in 1885, and gained the Lalande prize. Thollon continued this work until his death, and it has now been published in 33 maps with a total length of $10^m.23$ (33.6 feet), and contains about 3,200 lines, between the limits adopted, A and *b*, the positions of which were determined from 252 sharp lines adopted as "fundamentals."

Thollon made special efforts to distinguish the telluric rays from those entirely due to the sun; and with this end in view he observed the sun at different altitudes, noting the hygrometric conditions of the air. Of these 3,200 lines mapped, 2,090 were of solar origin, 866 telluric, and 246 mixed, that is to say resulting from the superposition of telluric and solar lines. The breadth and intensity of each line is given upon an arbitrary scale.

M. Bigourdan, in a review of Thollon's work, published in the May number of the Bulletin Astronomique, says that for the part of the spectrum studied no work is comparable with that of Thollon except the magnificent photographs of Rowland, and he finds upon a critical comparison of different regions of considerable extent that Rowland's photographs contain no lines not upon Thollon's chart, though the faintest lines given upon the chart are frequently lacking in the photographs. Between wave-lengths 5,262 and 5,337, for example, in Rowland's photograph, there are not half the number of lines that there are upon Thollon's chart, though it is probable that the original negatives would not show so large a difference.

Rowland's determination of elements in the sun.—Professor Rowland's examination by photography of the spectra of 58 elements and their comparison with the spectrum of the sun shows the existence in the sun of 35 different elements; the existence of 8 more in the sun is doubtful, while of 10 he finds no trace. The element represented by the greatest number of lines is iron, there being 2,000 or more lines in the spectrum of iron found also in the solar spectrum. Iron is followed by nickel, titanium, manganese, chromium, cobalt, carbon, with decreasing frequency of coincidences, ending with lead and potassium, for which but one line is found in common with the sun.

The full list of elements in the sun, arranged according to the intensity and the number of lines in the solar spectrum, is as follows:

Elements in the sun, arranged according to the intensity and the number of lines in the solar spectrum.

According to intensity.

- Calcium.
- Iron.
- Hydrogen.
- Sodium.
- Nickel.
- Magnesium.
- Cobalt.
- Silicon.
- Aluminium.
- Titanium.
- Chromium.
- Manganese.
- Strontium.
- Vanadium.
- Barium.
- Carbon.
- Scandium.
- Yttrium.
- Zirconium.
- Molybdenum.
- Lanthanum.
- Niobium.
- Palladium.
- Neodymium.
- Copper.
- Zinc.
- Cadmium.
- Cerium.
- Glucinum.
- Germanium.
- Rhodium.
- Silver.
- Tin.
- Lead.
- Erbium.
- Potassium.

According to number.

- Iron (2,000 +).
- Nickel.
- Titanium.
- Manganese.
- Chromium.
- Cobalt.
- Carbon (200 +).
- Vanadium.
- Zirconium.
- Cerium.
- Calcium (75 +).
- Scandium.
- Neodymium.
- Lanthanum.
- Yttrium.
- Niobium.
- Molybdenum.
- Palladium.
- Magnesium (20 +).
- Sodium.
- Silicon.
- Strontium.
- Barium.
- Aluminium (4).
- Cadmium
- Rhodium.
- Erbium.
- Zinc.
- Copper (2).
- Silver (2).
- Glucinum (2).
- Germanium.
- Tin.
- Lead (1).
- Potassium.

Doubtful elements.

- Iridium.
- Osmium.
- Platinum.
- Ruthenium.
- Tantalum.
- Thorium.
- Tungsten.
- Uranium.

Not in solar spectrum.

- Antimony.
- Arsenic.
- Bismuth.
- Boron.
- Nitrogen (vacuum tube).
- Cæsium.
- Gold.
- Indium.
- Mercury.
- Phosphorus.
- Rubidium.
- Selenium.
- Sulphur.
- Thallium.
- Præseodymium.

Substances not yet tried.

- Bromine.
- Chlorine.
- Iodine.
- Fluorine.
- Oxygen.
- Tellurium.
- Gallium.
- Holmium.
- Thulium.
- Terbium, etc.

Professor Rowland says: "With the high dispersion here used the 'basic lines' of Lockyer are widely broken up and cease to exist. Indeed it would be difficult to prove anything except accidental coincidences among the lines of the different elements. Accurate investigation generally reveals some slight difference of wave length or a common impurity. Furthermore, the strength of the lines in the solar spectrum is generally very nearly the same as that in the electric arc, with only a few exceptions, as, for instance, calcium. The cases mentioned by Lockyer are generally those where he mistakes groups of lines for single lines or even mistakes the character of the line entirely. Altogether there seems to be very little evidence of the breaking up of the elements in the sun, as far as my experiments go."

M. Janssen, in August, 1890, repeated the observations that he made in 1888, upon Mont Blanc, this time ascending to the summit. He confirmed completely his former result that the lines of the spectrum due to the action of oxygen in our atmosphere diminish with the altitude, indicating that at the limit of the atmosphere these rays would disappear entirely and in consequence that oxygen is not actually present in the sun's atmosphere. This conclusion had already received confirmation from a series of observations of the spectrum of an electric light placed on the Eiffel Tower, as viewed from the observatory at Meudon.

ECLIPSES.

Eclipses of 1889, *and* 1890.—During the year 1889, there were five eclipses, three of the sun and two of the moon; and during 1890, three eclipses, two of the sun and one of the moon. Two of the solar eclipses of 1889 were total, and one of 1890 was total over a portion of the central line.

The Almanac records also a lunar appulse on June 2, 1890, the nearness of the approach and the uncertainty as to the effect of the earth's atmosphere rendering it doubtful whether the moon would actually enter the earth's shadow. Of the eclipses of the moon nothing of especial interest has been reported. A brief summary of the observations of the solar eclipses is given below:

Total eclipse of the sun January 1, 1889.—The event of chief astronomical interest in the year 1889, was the eclipse of the sun on New Year's day, the last total solar eclipse visible in the United States in this century. The line of central eclipse crossed California, Nevada, Idaho, Wyoming, Montana, and Dakota, the width of the belt of totality being about 96 miles in California; the partial phases of the eclipse were visible over the greater part of North America, first contact being observed at Washington a few minutes before sunset. Ample preparations were made for utilizing the less than two minutes of totality, and printed circulars suggesting to amateur observers the most efficient manner of employing the means at their command were widely circulated. The most thoroughly equipped party in the field was that from the Harvard observatory under the charge of Prof. W. H. Pickering, at Willows, California. This party alone secured between 50 and 60 photographs taken with 14 telescopes or cameras and 8 spectroscopes, one of the telescopes being of 13 inches aperture, the largest ever used in observing a total solar eclipse. A party from the Lick observatory under Mr. Keeler was at Bartlett Springs; one from Washington University observatory, St. Louis, under Prof. H. S. Pritchett at Norman; one from Carleton College observatory under Professor Payne at Chico; and many other available points were occupied by individual astronomers or photographers. At Cloverdale the Pacific Coast Amateur Photographic Association was represented by 30 cameras.

Professor Holden has published a full report of the Lick observatory party and its coöperators—the frontispiece being an admirable photograph of the corona by Barnard, taken with a telescope of 3¼ inches aperture stopped down to 1¾ inches. Professor's Holden's "conclusions" in which he summarizes the observations are as follows:

I. That the characteristic coronal forms seem to vary periodically as the sun spots (and auroras) vary in frequency, and that the coronas of 1867, 1878, and 1889 are of the same strongly marked type, which corresponds, therefore, to an epoch of minimum solar activity.

II. That so-called "polar" rays exist at all latitudes on the sun's surface, and are better seen at the poles of the sun, simply because they are there projected against the dark background of the sky and not against the equatorial extensions of the outer corona. There appears to be also a second kind of rays or beams that are connected with the ring-like extensions. These are parts of the "groups of synclinal structure" of Mr. Ranyard.

III. The outer corona of 1889 terminated in branching forms. These branching forms of the outer corona *suggest* the presence of streams of meteorites near the sun, which, by their reflected light and by their native brilliancy, due to the collisions of their individual members, *may* account for the phenomena of the outer corona.

IV. The disposition of the extensions of the outer corona along and very near the plane of the ecliptic might seem to show that, if the streams of meteorites above referred to really exist, they have long been integral parts of the solar system.

V. The photographs of the corona which were taken just before contact II and just after contact III prove the corona to be a solar appendage, and are fatal to the theory that any large part of the coronal forms are produced by diffraction. - - -

VI. The spectroscopic observations of Mr. Keeler show conclusively that the length of a coronal line is not always an indication of the depth of the gaseous coronal atmosphere of the sun at that point, and hence to indicate the important conclusion that the true atmosphere of the sun may be comparatively shallow.

VII. Mr. Keeler draws the further conclusion in his report - - - that the "polar" rays are due to beams of light from brighter areas of the sun illuminating the suspended particles of the sun's gaseous envel-

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NOTE.—The conclusions III and IV appear to be contradictory to that expressed in I. The electrical theory announced by Dr. Hygins in the Bakerian lecture for 1885 seems to reconcile the conclusions I, III, and IV.

opes. In order that the conclusion may stand it is necessary to show that all these "polar" beams are composed of rectilinear rays. . . . An important conclusion from [the photographic and photometric] measures seems to be that it is impracticable to photograph the corona in full sunshine with our present plates, and that a photographic search for Vulcan is hopeless.

The Smithsonian Institution has published a series of photographs of the corona of this eclipse made by different observers and reduced for convenience to a uniform scale, and has also published a suggestive paper by Prof. F. H. Bigelow tracing a close agreement between magnetic lines of force computed for the sun and the curves of the polar filaments shown upon the Pickering photograph.

Eclipse of the sun 1889, *June* 27.—An annular eclipse visible in the southern part of Africa. Dr. Auwers and Dr. Gill obtained a number of measures of the cusps with the Cape heliometer.

Eclipse of the sun 1889, *December* 21–22.—Three principal points were available as observing stations: the southwest corner of the island of Trinidad totality lasting 1^m 46^s; Cayenne on the coast of French Guiana, totality 2^m 3^s; and Cape Lado a point on the western coast of Africa just south of St. Paul de Loanda, totality 3^m 12^s. Two expeditions went out to Africa, one sent by the United States Government under Prof. D. P. Todd, and provided with most elaborate apparatus, and the other from the Royal Astronomical Society of England under the direction of Mr. A. Taylor. Cloudy weather prevented both of these parties from securing observations. Another party from the Royal Astronomical Society under Father Perry, at the Salut Islands, was partially successful as far as observations go, but resulted most disastrously in the death of Father Perry from dysentery within a few days after the eclipse. M. de la Baume Pluvinel was also at the Salut Islands and secured a number of photographs. The Lick observatory party at Cayenne, Messrs. Burnham, Schaeberle and Rockwell, were successful; securing good photographs.

Eclipse of the sun 1890, *June* 17.—The annular eclipse of June 17, 1890, was central over portions of Northern Africa and Southern Asia, and was visible as a partial eclipse over the whole of Europe. In the southern part of Italy three-fourths of the sun's disk was covered by the moon. Observations partially successful were obtained by Professor Ricco at Palermo. At Canea, M. de la Baume Pluvinel secured several photographs of the partial and annular phases, and also of the spectrum of the annulus, the latter proving to be the same as the ordinary solar spectrum.

Eclipse of the sun 1890, *December* 11.—A total eclipse of the sun occurred on December 11, 1890, the central line being confined to the ocean south of Australia. In consequence of the earth's globular surface, the eclipse was annular at the beginning and end, and total between 13^h $55^m.3$ and 16^h $20^m.5$ Greenwich mean time. In portions of

Australia, and in Tasmania, and in New Zealand, it was visible as a partial eclipse. No observation of special interest was reported.

Mr. J. M. Schaeberle has published in the *Monthly Notices* a theory of the solar corona, in which he concludes that the corona is due to the light emitted and reflected by the filaments of matter thrown out by the sun, the corresponding forces being variable and with a period about the same as the sun-spot period. The rays of double curvature are explained by the rotation of the sun, and the apparent changes in the general form of the corona by the position of the observer with reference to the plane of the sun's equator.

The Smithsonian Institution published in 1889 a series of re-productions of a number of photographs of the eclipse of January 1, 1889, sent from various stations on the Pacific coast. The photographs are for convenience of comparison reduced to a uniform scale of about 1 inch diameter. Explanatory notes and remarks suggested by a study of the photographs are added by Prof. David P. Todd.

Mr. H. H. Turner in the Philosophical Transactions (vol. 180, p. 385–393) discusses the observations of the eclipse of August 29, 1886, made at the island of Grenada.

SOLAR PARALLAX AND THE TRANSITS OF VENUS.

Transits of Venus in 1761 *and* 1769.—A thorough, and probably the final, re-reduction of the observations of the transits of Venus in 1761 and 1769 has been made by Professor Newcomb in volume 2, part 5, of the astronomical papers of the American Ephemeris, a primary object being the determination of the position of the node of Venus. The value obtained for the solar parallax is 8″.79 with a probable error of + 0″.034.

Professor Harkness of the U. S. Naval Observatory has devoted several years of work to an elaborate discussion of the solar parallax and its related constants. His principal results are elsewhere referred to, the definitive value for the solar parallax being 8″.80905 ± 0″.00567.

The French photographs of the transit of Venus give for the solar parallax the value 8″.80 ± 0″.06.

OBSERVATORIES.

Information in regard to the work going on at astronomical observatories has been derived from the reports contained in the *Vierteljahrsschrift*, in the *Monthly Notices*, and in Loewy's *Observatoires astronomiques de Provence*, and also from the separate reports published by a few observatories. The compiler is indebted in some instances to directors of observatories who have communicated to him directly data in relation to the institutions under their charge. When it has seemed necessary to make a distinction, the year has been added to the note.

ALLEGHENY: *Langley.*—Work upon radiant energy has been continued, and the time service has been maintained as in previous years.

ALGIERS: *Trépied.*—A meridian circle of $0^m.19$ (7.5 inches) and an equatorial of $0^m.12$ (4.7 inches) have been added to the equipment. Observations have been made upon a catalogue of 10,000 stars in the zone − 18° to − 23°. It is expected that the photographic equatorial will soon be installed. (1889.)

ARMAGH: *Dreyer.*—Observations of nebulæ and physical observations of Jupiter and Saturn; time service.

BASEL: *Riggenbach.*—Devoted entirely to the instruction of students.

BERLIN: *W. Foerster.*—Observations with the transit circle, observations with the 9-inch equatorial of asteroids, comets, and double stars, and with the small transit of comparison stars and stars occulted by the moon.

BESANÇON: *Gruey.*—Observations of comets; horology. The observatory possesses an equatorial coudé.

BIRR CASTLE: *Lord Rosse.*—Preparing for publication a series of sketches of the milky way; measures of lunar heat during the eclipse of January 28, 1888, have been reduced.

BONN: *Schönfeld.*—Zone observations +40° to +50° with the transit circle. Reductions in a forward state. (1889.)

BORDEAUX: *Rayet.*—Preparations are being made for observing the zone −20° to −25°. The photographic equatorial has been mounted. (1889.)

BRESLAU: *Galle.*—Chiefly magnetic and meteorological work. Small transit used for time service.

CAMBRIDGE (England): *Adams.*—Mr. Newall has presented his 25-inch refractor to the university observatory, and the university authorities have voted to spend about $11,000 on its installation near the present observatory, and to appoint an observer, at $1,200 per annum, to devote himself to research in stellar physics. It is understood that the work with this instrument will be under the charge of Mr. H. F. Newall.

Volume 22 of the publications has been issued and deals with the observations from 1866 to 1869.

CAMDEN.—The amateur astronomical society at Camden, New Jersey, has a small observatory, with 5½-inch equatorial, transit instrument, chronograph, clock, etc.

CAPE OF GOOD HOPE: *Gill.*—With the meridian circle regular observations have been made of the sun, Mercury, Venus, comparison stars, stars occulted by the moon, etc. The heliometer has been constantly in use and much attention has been given to astronomical photography. Prof. J. C. Kapteyn has measured definitively 389 negatives of the plates of the southern photographic Durchmusterung, covering 8,769 square degrees of the sky. This work represents 489,490 observations of about 193,000 stars, or about 63 per cent. of the whole work.

Dr. Gill, the astronomer royal for the Cape, and Dr. Auwers, of Berlin, by taking alternate watches of observation (June 10 to August 26, 1889) secured an admirable series of observations of Victoria, which was in an exceptionally favorable position for determining the solar parallax. A large part of Dr. Gill's report for 1889 is devoted to the geodetic work which is under his direction.

CARLETON COLLEGE: *Payne.*—The first volume of publications consists of a catalogue of 644 comparison stars observed with the Repsold meridian circle, by Dr. Wilson.

CATANIA: *Riccò.*—The observatory recently founded at Catania will be chiefly devoted to astrophysics, photography, meteorology, and seismology. It contains a Merz refractor of $0^{m}.35$ (13.8 inches) aperture, one by Cooke of $0^{m}.15$ (5.9 inches), and a photographic telescope, by Steinheil, which will be used for photographing the zone +12° to +6°. (1890.)

CHAMBERLIN: *H. A. Howe.*—The disks for the 20-inch refractor are being worked by Clark, and the mounting is well advanced at the shop of Fauth & Co., Washington. The initial publication of the new observatory is a report upon observations of the eclipse of January 1, 1889.

DEARBORN: *Hough.*—An illustrated description of the new observatory at Evanston will be found in the Sidereal Messenger for October, 1889.

DENVER.—In addition to the working observatory founded by Mr. Chamberlin, an observatory for students is in course of erection. A 6-inch equatorial and a 3-inch transit have been ordered.

DENVER. (*See*, also, Chamberlin.)

DRESDEN: *von Engelhardt.*—Observations of nebulæ star-clusters and comets. Baron von Engelhardt has recently published a second part of his "Observations Astronomiques," containing principally measures of double stars, star charts, nebulæ, and comets. (1889).

DUNSINK: *Ball.*—A new reflecting telescope of 15 inches aperture has been presented to the observatory by Mr. Isaac Roberts for photographic researches on stellar parallax.

DÜSSELDORF: *Luther.*—Observations of small planets, and computation of their ephemerides. Since 1847, 1,474 observations of 172 asteroids have been made. (1889).

EDINBURGH: *Copeland.*—The site for a new observatory building two minutes of arc south of the present observatory was selected in 1889. The plans have been completed and it is hoped that the work of construction will soon be begun. It is interesting to note that though the new site is within 500 yards of the suburban railway, the porphyrite rock of which the hill consists does not appear to transmit any perceptible vibration from the railway even when the heaviest trains are passing. Dr. Becker has continued his determinations of the positions of nebulæ and work in stellar and solar spectroscopy.

GEORGETOWN: *Hagen.*—Observations of variable stars have been made systematically, and experiments in photographic observations of star transits by Father Hagen and his assistant, Father Fargis.

GENEVA: *Gautier.*—Chiefly engaged in testing chronometers and watches. Observations of the sun and of comets have been made with the equatorial. Dr. Raoul Gautier has been appointed professor of astronomy and director of the observatory, Col. E. Gautier retaining the title of honorary director.

GLASGOW (England): *Grant.* Transit circle observations.

GÖTTINGEN: *Schur.*—Heliometer used in measuring Præsepe, Pleiades, and double stars. (1889.)

GREENWICH: *Christie.*—In the report for 1889 it is noted that the observations with the transit circle by reflexion have been much facilitated and improved by using an amalgamated copper-bottom mercury trough for the artificial horizon. Two photographic objectives have been tried, one of 6 inches aperture to be used as a pilot for the 13-inch star-charting telescope stars, and the other of 4 inches in connection with the 28-inch refractor.

The annual visitation in 1890 took place on June 7. The collection of historical instruments and the new photographic equatorial especially attracted the attention of some 300 visitors present. It is proposed to put up a large new building with four wings to relieve the overcrowded condition of the older buildings. It is expected that the new 28-inch refractor will be installed at an early day. The 13-inch photographic equatorial was received from Grubb on March 17, 1890, and was mounted and made ready for use. The astronomer royal reported that the work of the observatory had proceeded without essential modification.

"The observations for the longitude of Paris made in 1888 have now been completely reduced and the definitive results found by the French and English observers are respectively, $9^m\ 21^s.04$ and $9^m\ 20^s.84$. In view of this unsatisfactory discordance - - - it seems desirable that the determination should be repeated with interchange of instruments as well as of observers."

The 1887 volume of Greenwich observations contains among its appendices the *ten-year catalogue* deduced from observations made from 1877 to 1886. The total number of stars is 4,059, the positions being given for 1880. 0

HARVARD COLLEGE: *Pickering.*—Miss C. W. Bruce, of New York, has made a gift of $50,000 to the Harvard observatory to be applied to the construction and maintenance of a photographic telescope having an objective of about 24 inches aperture and a focal length of 11 feet. The figuring of the lens has been intrusted to Alvan Clark, who has experienced some difficulty in securing proper glass. The Bache 8-inch telescope of similar construction has been in constant use in Cambridge for four years, and is now in Peru photographing the southern sky; with it stars too faint to be seen with the 15-inch refractor have been photographed, and a corresponding advantage is anticipated from the increase of the aperture to 24 inches.

Volume 17 of the *Annals* is now completed and consists of the following papers, which have been separately printed and distributed during the last few years: I. Magnitudes of stars employed in various nautical almanacs; II. Discussion of the Uranometria Oxoniensis; III. Photometric observations of asteroids; IV. Total eclipse of the moon, 1888, January 28; V. Total eclipse of the sun, 1886, August 29; VI. Detection of new nebulæ by photography; VII. A photographic determination of the brightness of the stars; VIII. Index to observations of variable stars; IX. Meridian-circle observations of close north polar stars; X. Meridian-circle observations of close south polar stars.

Volume 21, part 1, contains the observations of the New England Meteorological Society made during 1888. Volume 22 contains a long series of meteorological observations made on the summit of Pike's Peak, Colorado, between January, 1874, and June, 1888, by U. S. Army Signal Service observers.

KALOCSA: *Fenyi.*—Physical observations of the sun. (1889.)

KEW: *Whipple.*—Meteorological, magnetic, and solar observations.

KIEL: *Krueger.*—The catalogue of zone +55° to +65° has been published. Computation of the orbits of comets and asteroids.

KÖNIGSBERG: *C. F. W. Peters.*—Observations of zone +83° to +90°; also heliometer observations of wide double stars. (1889.)

KREMSMÜNSTER: *Wagner.*—Observations of comets and asteroids; time service.

LEIPZIG: *Bruns.*—Observations of zone +5° to +10°; observations with the heliometer; time service.

LUND: *Möller.*—Spectroscopic observations to determine the sun's rotation period. The printing of the Zone Catalogue is in progress. The second volume of Zone Observations, +36° to +40°, has been published.

LYNN (*Massachusetts*).—Private observatory of Mr. C. W. Wilson. Latitude +42°.5, longitude 71° west. The principal instrument is one of Alvan Clark & Sons' 6-inch refractors of unusual excellence.

LYONS: *André.*—Meridian work; physical observations of the sun and of Jupiter.

MCCORMICK: *Stone.*—Chiefly engaged in observations of double stars and nebulæ. Volume 1, part 4, of the Publications contains double-star measures made in 1885 and 1886 by Leavenworth and Muller.

MARSEILLES: *Stephan.*—Revision of Rümker's Catalogue; observations of comets, asteroids, nebulæ and variable stars. (1889.)

MELBOURNE: *Ellery.*—Transit-circle observations, observations of comets and astroids and of stellar spectra. The great reflector has been repolished, and its performance is reported as improved. The photographic telescope for the international chart work has been received and mounted. The Second Melbourne General Catalogue of Stars, containing 1,211 stars and embodying the results of observations made with the old transit circle from the beginning of 1871, has been published.

MILAN: *Schiaparelli.*—The 18-inch equatorial was used for double-star measures; the observations of Mercury, 1881–'88, were discussed, and the rotation period determined. (1889.)

MUNICH: *Seeliger.*—Work on a catalogue of 33,082 stars; observations of comets and measures of the star cluster in Perseus.

NATAL: *Nevill.*—Observations of the position of the moon. There has been formed a manuscript catalogue of about 4,000 observations of right ascensions of zodiacal stars used in determining the places of the moon during the years 1883–'88. Time service.

NICE: *Perrotin.*—Charlois has been remarkably successful in his search for new asteroids. The third volume of Annals contains a new chart of the solar spectrum by Thollon, the concluding part of the discussion of the theory of Vesta by Perrotin, and the observations made in the years 1887–'88.

O'GYALLA: *Konkoly.*—Observations of sun spots and meteors; photographic researches.

OXFORD UNIVERSITY: *Pritchard.*—Experimental work on the new photographic objectives by Grubb has occupied much time; the parallaxes of six more stars have been determined by photography. (1890.)

PARIS: *Mouchez.*—The large transit circle has been used for the sun, planets, and stars of Lalande's catalogue; the Gambey transit for observation of fundamental stars in groups of 24 to 48 hours; the Gambey circle for experiments on flexure and the determination of latitude; comets and nebulæ have been observed with the west equatorial, and the equatorial coudé has been used in determining the constants of refraction and aberration. The work for which the Paris observatory has been especially known of late years, astronomical photography, has been actively pursued by the Henrys. The frontispiece of Admiral Mouchez's report for 1889 is a representation of the great equatorial coudé of 18 metres focal length and 0.6 metre (23.62 inches) aperture. Attention has been given to photographing of stellar spectra by placing prisms of 22° or 45° in front of the objective of the telescope, and Admiral Mouchez has announced that spectroscopic observations will form a regular part of the observatory work in future.

POTSDAM: *Vogel.*—Astrophysical work, determination of the motion of stars in the line of sight by means of photography; spectrum analysis in general; photometric measures of large planets and a photometric

Durchmusterung of the northern sky; observations of sun spots. The new refractor for the photographic star chart is erected and some experimental work has been done. (1889.)

PRAG: *Safarik.*—Double-star measures; drawings of the moon; chiefly devoted to observations of variable stars. (1889.)

PRAG (University observatory): *Weinek.*—Drawings of moon; occultations. Time service. (1889.)

PULKOWA: *Bredichin.*—Prof. Otto Struve retired from the directorship of the observatory, which he has held for over 25 years, and has been succeeded by Dr. Bredichin, formerly director of the observatory at Moscow. Three volumes were issued in 1889: Volume 8 containing the catalogue of Bradley's stars, a volume containing an investigation by Lindemann of the photometric scale of the Bonn Durchmusterung, and the third volume, the "Jubilee" volume, with an historical account of the observatory for 25 years, a monograph on the 30-inch refractor, and a description of the astrophysical observatory. The volume contains several fine engravings of the observatory and 30-inch. (1889-'90.)

RADCLIFFE: *Stone.*—Transit-circle observations of the zone 0°-15°, and of the sun and moon.

ROME: *Denza.*—The new observatory of the Vatican has been built partly upon the site of the old observatory, founded in 1582, and partly upon a tower dating from the time of Leo IV. Special attention will be given to astronomical photography.

ROUSDON (Lyme Regis): *Peek.*—Observations of variables. Time service.

STOCKHOLM: *Gyldén.*—Largely engaged in mathematical researches upon orbits. Photographs have been taken of the Pleiades and of a region extending about 4° around the north pole. (1889.)

STONYHURST: *Sidgreaves.*—Father Perry, whose sad death immediately after observing the total eclipse of the sun on December 21, 22, 1889, has been elsewhere referred to, has been succeeded in the directorship of the observatory by Father Walter Sidgreaves. (1889.)

STRASSBURG: *E. Becker.*—Observations of comets and heliometer measures of the sun's diameter; also transit-circle observations of the sun and major planets.

SYDNEY: *Russell.*—Transit-circle observations, and with the 11½-inch equatorial observations of comets and of double stars. The photographic telescope for chart work has been mounted upon an elevated site 620 feet above the sea and 11 miles inland from the present observatory. Each instrument has its own group of accumulators, conveniently charged by the help of a gas engine.

SMITHSONIAN ASTRO-PHYSICAL OBSERVATORY: *Langley.*—An astrophysical observatory has been established as a department of the Smithsonian Institution at Washington, occupying at present a temporary building in the Smithsonian grounds, erected in 1889–'90. The principal instruments are a very large siderostat by Grubb, a large spectro-bolometer, special galvanometer, and resistance box. Researches in telluric and astro-physics will be carried on.

SWARTHMORE COLLEGE: *Miss S. J. Cunningham.*—The observatory building contains four rooms: A transit room, in which is a 3-inch Warner and Swasey transit and mean-time clock; a pier room at present utilized as a sidereal clock room; a work room containing the chronograph, chronometer, and a small reference library; and the dome, in which is a 6-inch Warner and Swasey equatorial. Connected with the observatory is the signal service station of the state weather service, fully provided with the necessary meteorological and other apparatus. (1890.)

TACUBAYA: *Anguiano.*—The construction of the new observatory has progressed favorably, the photographic department being entirely finished and the instruments mounted. The photographic equatorial is by Grubb, of the pattern adopted by the astrophotographic congress in 1889 and furnished for most of the observatories taking part in the international chart. Among the minor apparatus added to the equipment of the observatory may be mentioned a complete portable photographic outfit; a Merz polariscope for the 15-inch equatorial; a Pritchard's wedge photometer by Hilger; a mercury artificial horizon by Gauthier for the meridian circle; a complete meteorological outfit; a petroleum motor and electric light installation.

In August, 1889, two additions were made to the observatory staff, Messrs. Camilo A. Gonzalez and Guillermo Puga, who have been assigned to duty on the meridian circle. They have been engaged in studying the instrumental constants and have undertaken the observation of certain stars to the tenth magnitude, conveniently situated for reference stars for the zone of the photographic map assigned to the Tacubaya observatory. Sr. Felipe Valle has been engaged with the equatorial in observations of comets, asteroids, and nebulæ.

A series of daily observations of sun spots and faculæ has been made. Photographs of the sun have been taken with the photoheliograph. Two parties were sent out to observe the total solar eclipse of October 22, 1889, one to Yucatan and one to San Luis Potosi. (1890.)

TANANARIVO: *Colin.*—An observatory has been established on a hill about 4,400 feet high a short distance to the east of Tananarivo on the island of Madagascar. It has an equatorial, meridian instrument, and photographic telescope for solar work. (1889.)

TOKYŌ: *Terao.*—A large number of observations of comet *e*, 1888, made by Professor Teara and Mr. J. Midzuhara have been published as the second fasciculus of volume 1 of the *Annals.* (1889.)

TOULOUSE: *Baillaud.*—The photographic telescope has been mounted.

UNITED STATES NAVAL OBSERVATORY: *McNair.*—The reports of the superintendents of the Naval Observatory show no material change in the character of the work from the years immediately preceding. On June 28, 1890, Capt. F. V. McNair succeeded Capt. R. L. Phythian as Superintendent, Capt. McNair's report covering the fiscal year June 30, 1890. The walls of the main building for the new observatory were practically completed by the end of 1890; also the great equatorial and clock and observer's rooms. The iron work for the three transit-circle rooms is ready. The buildings will scarcely be ready for occupancy before the summer of 1892.

UPSALA: *Dunér.*—From an extensive series of spectroscopic observations to determine the rotation period of the sun, it appears that the period varies from 25.5 days to 38.6 days, increasing with the heliographic latitude.

VIENNA (*von Kuffner's* observatory): *Herz.*—The latitude from observations with the Repsold meridian circle, 1889-'90, is $+48^\circ\ 12'\ 46''.67$.

WASHINGTON (Catholic University of America): *Searle.*—A small observatory has been built at the Catholic University in the suburbs of Washington (D. C.), and is under the direction of Rev. G. M. Searle. The position is latitude $+38^\circ\ 56'\ 15''$; longitude $5^h\ 8^m\ 0^s.0$ west of Greenwich. The telescope, which will be mounted in 1891 is 9 inches aperture, 9 feet focus, glass and tube by Clacey, mounting by Saegmuller (Fauth & Co.). The cells and center piece of tube are made of aluminum. A small meridian circle, and photographic and spectroscopic apparatus will also be provided. A 5-inch telescope is now in use. (1890.)

WASHINGTON. (*See*, also, Georgetown; also, Smithsonian astrophysical observatory; also, U. S. Naval Observatory.)

WASHBURN: *Comstock.*—The sixth volume of publications contains the meridian observations of 1887 and observations of double stars.

YALE: *Newton.*—The heliometer triangulation of the region near the north pole has been completed, and some observations of Iris, Victoria and Sappho have been obtained in coöperation with the observatories at the Cape of Good Hope and Leipsic, for the determination of the solar parallax.

ZURICH: *Wolf.*—Physical observations of the sun.

ASTRONOMICAL INSTRUMENTS.

In the fourth part of the Bulletin of the Astro-photographic congress, Dr. H. C. Vogel describes the photographic refractor constructed for the observatory at Potsdam by the Repsolds. This instrument has two objectives; eye-piece and plate-holder are in the same tube, conforming to the resolutions of the congress in 1887, but the peculiarity is in the form of mounting, which is quite different from both the English and the French forms. The pillar that supports the polar axis is not upright, but L-shaped, the lower part being inclined nearly in the plane of the equator, the upper almost at right angles to this, extending toward the north pole and inclosing the polar axis. The support possesses very great stability, and its form permits an uninterrupted motion of the telescope in all positions.

In *Engineering* for December 19, 1890, will be found a description of the Melbourne photographic telescope made by Sir Howard Grubb.

An instrument for comparing and measuring celestial photographs, somewhat similar to that designed by Mr. Roberts, has been devised by Mr. Common.

An apparatus for eliminating personal equation in the observation of sudden phenomena, such as the disappearance of a star when occulted by the moon has been devised by Mr. S. P. Langley, and is described in the Bulletin of the Philosophical Society of Washington, vol. XI. The principle of the method consists in associating a motion, real or apparent, of the object, with intervals of time so that the apparent position of the object at the instant of the occurrence of any phenomenon being noted the time of the occurrence will be known. Experiments made with artificial stars show that it is quite possible for a comparatively inexperienced person to observe an occultation with a probable error of only one-fortieth of a second.

The great Lick refractor of 36 inches diameter is to be surpassed by one still larger, ordered for the University of Southern California, at Los Angeles. This lens is to be 40 inches in diameter, and the crown glass disk for the achromatic combination is now in the hands of the Clarks, who pronounce it a remarkably fine piece of glass.

It may perhaps be mentioned here that a bill was introduced in the United States Congress making an appropriation of $1,000,000 for a refractor of 5 feet aperture for the U. S. Naval Observatory, but the plan never received support from the Government astronomers.

Mr. Brashear has under way at his shop in Allegheny a 16-inch objective for Carleton College Observatory, one of 12 inches for Brown University, and a second of 12 inches for Mr. G. E. Hale, of Chicago. He is also making a large spectroscope and spectrograph for Professor Young, at Princeton, which is expected to be the finest in the United States; a very complete spectroscope with Jena glass objectives and prism is being made for Carleton College, and a new star spectroscope for Lick Observatory. For the Willard photographic telescope of the Lick Observatory, he is making an equatorial mounting with controlled clock.

MISCELLANEOUS.

Personal equation.—The attention of astronomers interested in the subject of personal equation should be directed to a paper prepared by a physiologist, Dr. E. C. Sanford, of the Johns Hopkins University, and published in volume 2 of the American Journal of Psychology. An important contribution to the astronomical side of the subject is an investigation by Dr. Wislicenus, of the Strasburg Observatory, who has investigated the personal equation in transit observations, not only for a horizontal position of the telescope, but for all inclinations. By placing a small convex lens behind the ocular an artificial star is obtained which is easily moved in the plane of the reticule with a velocity corresponding to any declination. Dr. Wislicenus concludes from his experiments that the inclination of the telescope has a considerable effect upon the observer's personal equation.

One of the essays contributed to the celebration of the Pulkowa Jubilee was a discussion of absolute personal equation by H. G. van de Sande Bakhuyzen. The artificial star observed was the meridian mark of the transit circle, to which an apparent motion was given by interposing a prism fixed excentrically to a circular rotating plate. Very satisfactory results were obtained. The personality depending upon direction of apparent motion seemed to be generally small for seven observers who tried the apparatus.

ASTRONOMICAL SOCIETIES.

The Astronomical Society of the Pacific.—Under the leadership of Professor Holden and the astronomers at the Lick Observatory the Astronomical Society of the Pacific was founded February 7, 1889, as a result of the cordial coöperation of amateur and professional astronomers in successfully observing the total solar eclipse of the preceding New Year's day. Any person interested in astronomy is invited to join its membership. Three meetings each year are held in San Francisco and three meetings at Mount Hamilton. An excellent series of publications, in octavo form, issued at irregular intervals, has reached the second volume. These "publications" contain papers read before the society, and also notices from the Lick Observatory prepared by members of the observatory staff. A fund has been established known as the "Donohoe fund for the maintenance of the comet medal of the Astronomical Society of the Pacific," the principal conditions of the gift, a medal of bronze, being the discovery of a new comet or the first precise determination of position of a periodic comet at any one of its expected returns. The discoverer is to make his discovery known in the usual way, and also to communicate it immediately to the director of the Lick Observatory. No application for the bestowal of the medal is required.

The British Astronomical Association.—A new astronomical society, to be called the British Astronomical Association, has been formed in England to meet the wishes and needs of those who find the subscription of the Royal Astronomical Society too high, or its papers too advanced, or who are, as in the case of ladies, practically excluded from becoming fellows; it is also to afford a means of direction and organization in the work of observation to amateur astronomers. The new society is thus to be regarded as supplementary to the older one, and not its rival. The first general meeting was held on October 24, 1890, in the hall of the Society of Arts, Adelphi, London, and the officers nominated by a provisional committe were elected, Capt. W. Noble being made president. The sections under which the work of observation is organized are: Meteoric, solar, lunar, spectroscopic, and photographic, colored stars, variable stars, double stars, and Jupiter, each section being presided over by an amateur astronomer who has devoted special attention to the subject named. The first number of the Journal appeared in October, 1890, under the able editorship of Mr. E. W. Maunder.

Gesellschaft Urania.—The building forming the headquarters of the Gesellschaft Urania was completed in July, 1889, and is described at some length by Dr. M. W. Meyer in the February and March numbers of *Himmel und Erde.* The Gesellschaft is for the purpose of popularizing science. The chief astronomical instrument is a 12-inch refractor by Bamberg, the glass for which was made by Schott & Co., of Jena. There are also a 6-inch and a 4-inch refractor, a 6-inch reflector, a 2½-inch transit, and a 5-inch comet-seeker. These instruments are for the use of visitors, and for cloudy nights a collection of 700 lantern slides is provided.

The thirteenth meeting of the Astronomische Gesellschaft was held at Brussels, Septembr 10 to 12, 1889. The next meeting is at Munich in 1891.

Astronomical prizes.—The Lalande prize of the French Academy of Sciences was awarded for 1889 to M. Gonnessiat of the Lyons observatory, the Valz prize to Charlois, and the Janssen prize to Lockyer.

In 1890 the Lalande prize was awarded to Schiaparelli for his observations determining the rotation of Mercury and Venus, the Valz prize to Glasenapp for his determination of the orbits of double stars, and the Janssen prize to Young. The Damoiseau prize, for which but one memoir was presented, was continued for another year with the same subject: To perfect the theory of the inequalities of long period caused by the planets in the motion of the moon.

The Copley medal of the Royal Society was awarded on November 20, 1890, to Professor Simon Newcomb for his contributions to gravitational astronomy.

The first award of the Donohoe medal was made to Mr. W. R. Brooks for the discovery of a comet on March 19, 1890; the second to Mr. W. F. Denning for his comet of July 23, 1890, and the third to Monsieur Jérôme Coggia, astronomer of the observatory of Marseilles, for his discovery of a comet on Juiy 18, 1890, this being the eighth comet discovered by M. Coggia.

A generous gift has been made in aid of astronomical research by Miss C. W. Bruce, of New York, who placed in the hands of Professor Pickering, director of the Harvard Observatory, $6,000. In answer to a circular issued by Professor Pickering, numerous requests were received for aid from this fund, and various sums were awarded by Professor Pickering so as to aid as wide a range of astronomical subjects as possible, and to aid investigators in all parts of the world.

Among new works of general interest to astronomers may be mentioned Miss Clerke's "The System of the Stars;" a new edition of Chambers' Astronomy in three volumes. The first two volumes of an able "Traité de mécanique céleste," the first containing the general theory of perturbations, and the second on the figures of rotation of celestial bodies; these are to be followed by a third volume on the lunar theory, theory of Jupiter's satellites, Hansen's method for the calculation of perturbations, and other methods of recent date. Another work which has been found useful as a text-book is Dziobek's *Die mathematischen Theorien der Planeton*–Bewegungen.

Dr. Scheiner has published a treatise on spectrum analysis which is intended to form the first volume of complete work on astrophysics.

The first volume of the national edition of the works of Galileo has appeared under the patronage of the King of Italy.

Dr. Dreyer has published a biography of Tycho Brahe upon which he has been at work for several years past.

A very interesting paper on Bowditch, who translated Laplace's "Mécanique Céleste," has been contributed by Prof. Joseph Lovering to the Proceedings of the American Academy of Sciences.

An index to the literature of spectroscopy, compiled by Mr. Alfred Tuckerman, has been published in the Smithsonian Miscellaneous Collections. It contains a bibliography of the history of the subjects; of books; of apparatus; of spectrum analysis in general; of qualitative analysis; of quantitative analysis; of absorption spectra; of alkalies and alkaloids; of astronomical spectroscopy; of carbon compounds, and of the spectra of metals; there is also a list of 799 authors. The number of titles is 3,829.

Another useful contribution to astronomical bibliography is the catalogue of the Crawford Library at the Royal Observatory at Edinburgh, presented to the observatory by the Earl of Crawford, and formerly constituting the library of the Dun Echt Observatory. The catalogue was compiled by the present astronomer royal for Scotland, Mr. Copeland, and contains a number of rare works.

Reference should also be made to a new edition of M. Lancaster's useful little *Liste générale des observatoires*, appearing in 1890 with many additions and corrections.

ASTRONOMICAL BIBLIOGRAPHY FOR 1889.

A brief bibliography of astronomy for the year 1890 having been contributed to the *Sidereal Messenger* for 1891, it seems unnecessary to cover more than the year 1889 in the present review. The titles given below include the most important books and journal articles of 1889, that have come under the compiler's notice, some few titles having been taken from reviews or catalogues, where the publications themselves have not been accessible.

In the reference to periodicals the volume and page are simply separated by a colon; thus: Astron. Jour. 8:153 indicates volume 8, page 153, of the Astronomical Journal. The following less obvious abbreviations occur:

Abstr. = Abstract.
Am. = American.
Bd. = Band.
d. = di, der, del, etc.
ed. = edition.
Hft. = Heft.
hrsg. = herausgegeben.
il. = illustrated.
j., jour. = journal.
k. k. = kaiserlich, königlich.
Lfg. = Lieferung.
M. = Marks.
n. d. = no date.
n. p. = no place of publication.
n F. = neue Folge.
n. s. = new series.
Not. = Notices.
Obsvy. = Observatory.
p. = page.
pl. = plates.
portr. = portrait.
pt. = part.
r. = reale.
Rev. = Review.
s. = series.
sc. = science, scientific.
vol. = volumes.

NECROLOGY OF ASTRONOMERS FOR 1889-'90.

Biographical sketches of most of the following astronomers are to be found in the columns of the *Astronomische Nachrichten*, in the *Vierteljahrschrift, der Astronomischen Gesellschaft*, or in the *Monthly Notices* of the Royal Astronomical Society.

Adolph (Carl). Born at Nordstemmen, Hanover, April 8, 1838; died January 3, 1890.

Cacciatore (Gaetano). Born at Palermo March 17, 1814; died at Palermo June 16, 1889, *æt.* 75.

De LaRue (Warren). Born at Guernsey January 18, 1815; died April 19, 1889, *æt.* 74.

Erck (Wentworth). Born in Dublin, 1827; died at Sherrington, Wicklow, January 15, 1890, *æt.* 63.

Fearnley, (Carl Frederik). Born at Frederiksbald December 19, 1818; died August 22, 1890, *æt* 72.

Fievez (Charles). Died February 2, 1890, *æt* 46.

Montigny (C. M. V.). Died at Schaerbeck, March 16, 1890, *æt* 71.

Newall (Robert Stirling). Born in Dundee May 27, 1812; died April 21, 1889, *æt.* 77.

Oom (Fréderico Augusto). Born at Lisbon December 4, 1830; died at Lisbon July 24, 1880, *æt* 60.

Perry (Stephen Joseph). Born in London August 26, 1833; died at sea near Demarara, December 25, 1889, *æt.* 56.

Peters (Christian Heinrich Friedrich). Born at Coldenbüttel, Schleswig, September 19, 1813; died at Clinton, New York, July 19, 1890, *æt.* 77.

Respighi (Lorenzo). Born at Cortemaggiore, Pracenza, October 7, 1824; died at Rome December 10, 1889, *æt.* 75.

Rosenberger (Otto August). Born at Tukkum, Russia, August 10, 1800; died at Halle January 23, 1890, *æt.* 90.

Schultz (Herman). Born at Nygvarn, Södermanland, July 7, 1823; died at Stockholm May 8, 1890, *æt.* 67.

Tempel (Ernst Wilhelm Leberecht). Born at Nieder-Kunersdorf, Saxony, December 4, 1821; died at Arcetri March 16, 1889,* *æt.* 66.

Weld (Alfred). Born August 5, 1823; died at Grahamstown July 24, 1890, *æt.* 67.

ASTRONOMICAL BIBLIOGRAPHY, 1889, 1890.

Asteroid 80.

Bryant (R.) Orbit of the planet (80) Sappho. Astron. Nachr., 121: 321–32.

——. Orbit of planet (80) Sappho, the secular perturbation of the minor planets upon elements of that orbit, and the mass of planet Jupiter. Astron. Jour., 8: 185–9.

Kirkwood (D.) Inclination of the asteroids. Sid. Mess., 8: 305–7.

Lehmann (P.) Zusammenstellung der Planeten-Entdeckungen im Jahre 1888. Vrtljschr. d. astron. Gesellsch., 24: 4–9.

Astronomers.

Morton (E. J. C.) Heroes of science. Astronomers. 8+341 p. 12mo. London and New York, [1889].

Astronomical Society of the Pacific.

[By-laws, etc. Society organized Feb. 7, 1889.] Pub. astron. soc. Pacific 1: 1–7.

Meeting of the Astronomical Society of the Pacific. Sid. Mess., 8: 358.

Astronomy.

Ball (R. S.) Elements of astronomy. New ed. 4+459 p. 12mo. London, 1889.

Holden (E. S.) List of the principal astronomical journals, transactions of societies and books of reference.] Pub. astron. soc. Pacific 1: 15. 1889.

——. Work of an astronomical society. Pub. astron. soc. Pacific 1: 9–15. 1889.

Parker (W. H.) Familiar talks on astronomy, with chapters on geography and navigation. 13+264 p. 12°. Chicago, 1889.

Porter (J. G.) Our celestial home. An astronomer's view of heaven. 116 p. 16mo. New York, [1889].

Láska (W.) Lehrbuch der sphärischen und theoretischen Astronomie und der mathematischen Geographie. 12+280 p., 1 pl. 8vo. Stuttgart, 1889.

Young (C. A) A text-book of general astronomy, for colleges and scientific schools. 8vo. Boston, 1889.

Astronomy (Bibliography of).

Houzeau (J. C.) Bibliographie générale de l'astronomie.

Astronomy (History of).

Bertin (G.) Babylonian astronomy. Nature 40: 237, 285.

Epping (J.) Astronomisches aus Babylon. 190 p. il. 8vo. Fribourg-en-Brisgau, 1889.

Astronomy (Progress of).

Flammarion (C.) Les progrès de l'astronomie pendant l'année, 1888. L'Astron. 8: 162–74. 1889.

Winlock (W. C.) Account of the progress in astronomy in the year 1886. Smithsonian rept. 1886–'87: 991–87. *Also*, Reprint.

Chronometers.

Hilfiker (J.) L'influence de la pression de l'air sur la marche des chronomètres. 22 p. 12mo. Neuchâtel, 1889.

Repr. from: Bull. Soc. d. sc. nat. de Neuchâtel, 17.

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* Erroneously given as 1888 in the Review of Astronomy for 1887–'88.

Comet Winnecke.

VON HAERDTL (E.) Bahn des periodischen Kometen Winnecke in den Jahren 1858–'86. II. Theil. 38 p. 4to. Wien, 1889.

Comet 1867 III.

BROCH (P.) Bahnbestimmung des Cometen 1867 III. Sitzungsb. d. k. Akad. d. Wissensch. in Wien, 97. 2. Abth. *Also, abstr.:* Astron. Nachr., 121: 353–8.

Comet 1880 V.

BEEBE (W.) and PHILLIPS (A. W.) Orbit of Swift's comet 1880 V, determined by Gibbs's vector method. Astron. Jour., 9: 113–121.

Comet 1887 I.

OPPENHEIM (H.) Definitive Bestimmung der Bahn des grossen Südcometen 1887 I. Astron. Nachr., 121: 337–42.

Comet 1889, Jan. 15.

BARNARD (E. E.) Search for the comet reported, 1889, Jan. 15, by Mr. Brooks. Astron. Jour., 8: 168.

Comet 1889 V.

BARNARD (E. E.) Companions to comet *d* 1889 (Brooks). Astron. Jour., 9: 77–78.

——. Companions to comet *d* 1889 (Brooks). Sid. Mess., 8: 360–63.

——. A very remarkable comet. Pub. astron. soc. Pacific 1: 72.

CHANDLER (S. C.) Action of Jupiter in 1886 upon comet *d* 1889, and the identity of the latter with Lexell's comet of 1770. Astron. Jour., 9: 100–3.

Comets.

BREDICHIN (T.) Quelques mots sur l'origine des comètes périodiques. Astron. Nachr., 120: 331. 1889. *Also:* Bull. Soc. imp. d. nat. de Moscou, 1889, No. 2.

CALLANDREU (O.) Théorie des comètes périodiques. 64 p. 4to. Paris, 1889.

Repr. from: Ann. obs. d. Par. 20.

COMETARY discoveries during the years 1840–'68. Obsry., 12: 435.

DENNING (W. F.) Notes on comets and comet seeking. Obsry., 12: 256, 285, 311, 349, 372, 403, 433.

KREUTZ (H.) Bericht über Cometen. Vrtljschr. d. astron. Gesellsch., 24: 293–8. 1889.

MAUNDER (E. W.) Comet 1887 I and cometary tails. Obsry., 12: 70–4.

SCHULHOF (L.) Notes sur quelques comètes à courte période. Bull. astron., 6: 465–71.

TISSERAND (F.) Théorie de la capture des comètes périodiques. Bull. astron., 6: 241, 289.

Comets of 1888.

KREUTZ (H.) Zusammenstellung der Cometen-Erscheinungen des Jahres 1888. Vrtljschr. d. astron. Gesellsch., 24: 9–17.

Computing Machines.

BABBAGE (H. P.) Babbage's calculating engines . . . 8+342+3 p. il. portr. pl. Lond., 1889.

Corona (Solar).

ABNEY (W. de W.) and THORPE (T. E.) Determination of the photometric intensity of the coronal light . . . eclipse 1886, Aug. 28–29. Phil. Trans., 363–84. 1889.

BIGELOW (F. H.) Solar corona discussed by spherical harmonics. 22 p., 1 pl. 4to. Washington, 1889.

Smithsonian publication No. 691.

Cosmogony.

CROLL (J.) Stellar evolution and its relations to geological time. 11+118 p. 12mo. New York, 1889.

Rev. by Fowler (A.) Nature 40: 199.

HIRN (G. A.) Constitution de l'espace céleste. 332 p., 1 pl. 4to. Paris, 1889.

Dearborn Observatory.

HOUGH (G. W.) New Dearborn Observatory. il. Sid. Mess., 8: 341–48.

De La Rue (Warren) [1815–'89].

HUGGINS (MARGARET L.) [Obituary notice . . .] Obsry., 12: 244–50.

Double Stars.

CLERKE (A. M.) New double stars. Nature 41: 132.

Earth.

CALLANDREAU (O.) Remarques sur la théorie de la figure de la terre. Bull. astron., 6: 185–92.

HOWE (H. A.) Earth tremors. Sid. Mess., 8: 448–49.

POINCARÉ (H.) Figure de la terre. Bull. astron., 6: 5, 49.

SCHIAPARELLI (G. V.) Rotation de la terre sous l'influence des actions géologiques. 32 p. 8vo. St.-Pétersbourg, 1889.

WOODWARD (R. S.) The mathematical theories of the earth. 23 p. 8vo. Salem, 1889.

Address as vice-president of Sect. A, Amer. Ass. Adv. Sc., Toronto, 1889.

Easter.

DATES de la fête de paques . . . [1582–2200]. L'Astron. 8: 418. 1889.

Eclipse of the Sun, 1886, August 28–29.

PICKERING (W. H.) Total eclipse of the Sun, August 29, 1886. Ann. Harv. Coll. Obsry., 18: 85–111. (v. 18, no. 5.) 4 pl. *Also*, Reprint.

Eclipse of the Sun, 1889, January 1.

HOLDEN (E. S.) [Preliminary report] on the solar eclipse of January 1, 1889. il. Obsry., 12: 130–4.

REPORTS on the observations of the total eclipse of the Sun of January 1, 1889, published by the Lick Observatory. 10+210 p. il. 8vo. Sacramento, 1889.

PICKERING (W. H.) [Photograph of the corona taken during] the total solar eclipse of January, 1889. Sid. Mess., 8: 337–39.

TODD (D. P.) Photographs of the corona . . . [with notes on the] structure of the corona. 10 p., 2 pl. 4to. Washington, 1889.

Smithsonian publication No. 692.

Eclipse of the Sun, 1889, December 21.

HOLDEN (E. S.) Lick Observatory expedition to observe the solar eclipse of December 21, 1889. Sid. Mess., 8: 339–41.

Encke (J. F.) Gesammelte mathematische und astronomische Abhandlungen. 3. Band. Astronomische und optische Abhandlungen. 158 p. 8vo. Berlin, 1889.

Fedorenko (Iwan) [1827–'88].

LEWITZKY (G.) Todes-Anzeige. Astron. Nachr., 120: 319.

Geodesy.

GORE (J. H.) Bibliography of geodesy. Rept. U. S. Coast and Geod. Surv. 1887: 312–512 (Rept. 1887, App. 16). *Also*, Reprint.

Harvard College Observatory.

PICKERING (E. C.) The Bruce photographic telescope. 1 p. 4to. Cambridge, 1889.

PICKERING (E. C.) [Circular showing the need for] a large photographic telescope. 4 p. 4to. Cambridge, 1888. *Also:* Sid. Mess., 8: 304.

Horizon (Artificial).

MAILHAT (—.) Nouveau bain de mercure, perfectionné. L'Astron., 8: 107. 1889.

Houzeau.

LANCASTER (A.) Notes biographiques sur J. C. Houzeau. 120 p., portr. Bruxelles, 1889.

Huyghens (C.)

ŒUVRES complètes . . . Tome 2. 6+639 p., 1 pl. La Hague, 1889.

Jupiter (Satellites of).

DOWNING (A. M. W.) [Glasenapp's discussion of eclipses of Jupiter's satellites.] il. Obsry., 12 : 173, 210.

Jupiter.

BARNARD (E. E.) Observations . . . with a 5-inch refractor during the years 1879–1886. il. Pub. astron. soc. Pacific, 1 : 89–111.

FLAMMARION (C.) Le monde de Jupiter. il. L'astron., 8 : 361–401. 1889.

HOLDEN (E. S.) Drawings . . . made with the 26-inch equatorial at Washington during 1875. il. Pub. astron. soc. Pacific, 1 : 111. 1889.

[L'OCCULTATION de Jupiter. 1889. Aug. 7.] il. L'Astron., 8 : 322.

TERBY (F.) [Structure de la bande nord équatoriale de Jupiter.] 4 p. il. 8vo. Bruxelles, 1889. Bull. Acad. roy. de Belg., 3. s., 18, nos. 9, 10.

———. Same. 6 p. il. 8vo. Bruxelles, 1890. Bull. Acad. roy. de Belg., 3. s., 18, No. 12, 1889.

WILLIAMS (A. S.) Zenographical fragments: the motions and changes of the markings on Jupiter during 1886–87. 118 p., 9 pl. 8vo. London, 1889.

Jupiter (Orbit of).

HILL (G. W.) Leverrier's determination of the second-order terms in the secular motions of the eccentricities and perihelia of Jupiter and Saturn. Astron. Jour., 9 : 89–91.

Karlsruhe Observatory.

VERÖFFENTLICHUNGEN . . . Heft 3. 8+204 p., 3 pl. 4to. Karlsruhe, 1889.

von Kuffner Observatory.

PUBLICATIONEN der von Kuffner'schen Sternwarte in Wien. 1. Band. 217 p., 12 pl. 4to. Wien, 1889.

Le Verrier (U. J. J.) [1811–77].

STATUE . . . à l'observatoire de Paris. L'Astron., 8 : 281. 1889.

Lick Observatory.

HOLDEN (E. S.) L'observatoire Lick. il. L'Astron., 8 : 241, 305. 1889.

Lunar theory.

FRANZ (J.) Die Konstanten der physischen Libration des Mondes, abgelietet aus Schlüter's Beobachtungen. Königsberg, 1889.

Rev. by R[adau] (R.) Bull. astron., 6 : 399–407.

McCormick Observatory.

PUBLICATIONS . . . v. 1, pt. 4. Double stars. 1885–86. [51] p. 8vo. Univ. of Virginia, 1889.

Mars.

FLAMMARION (C.) Changements actuellement observés à la surface de la planète Mars. il. L'Astron., 8 : 208, 285. 1889.

———. Observations de Mars faites à l'observatoire Lick . . . il. L'Astron., 8: 180–84. 1889.

GERIGNY (P.) Les marées sur Mars. L'astron., 8 : 381–8. 1889.

H[OLDEN] (E. S.) Variations of the surface of Mars. Pub. astron. soc. Pacific, 1 : 122.

MAC COLL (H.) A journey to the planet Mars. Nature. London, 1889.

Rev. by Gregory (R. A.) Nature, 40 : 291.

MEISEL (F.) Versuch, die Verdoppelung der auf der Marsoberfläche beobachteten Linien auf optischen Wege zu erklären. Astron. Nachr., 121 : 371.

NOUVELLES découvertes sur Mars: canaux, lacs et mers dédoublés. il. L'astron., 9 : 401–11. 1890.

SCHIAPARELLI (G. V.) Sur la planète Mars. il. L'Astron., 8 : 19, 42, 89, 124. 1889.

Mechanics (Celestial).

Tisserand (F.) Traité de mécanique céleste. Tome 1. 474 p. 4to. Paris, 1889.

Traxter (R. P.) Principles of mechanics as applied to the solar system. 70 p. il. 8vo. San Francisco, 1889.

Meteors.

Bredichin (T.) Quelques propriétés remarquables des courants météoriques. Vrtljschr. d. astron. Gesellsch., 24: 273–9. 1889.

Denning (W. F.) Determination of attenuated meteor-streams. Obsry., 12: 182.

Kleiber (J.) Petite histoire des étoiles filantes. L'Astron., 8: 413. 1889.

Lockyer (J. N.) Notes on meteorites. Nature, 39: 402; 40: 136.

Monck (W. H. S.) Meteors and meteorites. Sid. Mess., 8: 395–402.

Micrometers (Double image).

Brendel (M.) Ueber ein neues von Herrn Dr. Wellmann construirtes Doppelbild-Mikrometer. Vrtljschr. d. astron. Gesellsch., 24: 268–72, 1889.

Moon.

Boys (C. V.) Heat of the moon and stars. il. Proc. roy. soc., 47: 480–99.

Langley (S. P.) Temperature of the moon. Am. J. Sc., [38]: 421–40. 1889.

——. Same. Mem. nat. acad. sc., 4: 103–212. 26 pl. 4°. 1889. *Also*, Reprint.

Milky way.

Plassmann (J.) Ueber Grösse, Gestalt und Sternfülle der Milchstrasse. 10 p. 8vo. n. p., n. d.

Mitchell (Ormsby Mcknight).

Porter (J. G.) Ormsby Mcknight Mitchell. Sid. Mess., 8: 442–47.

Nebula in Lyra

Hall (A.) Note on the ring-nebula in Lyra. Astron. Jour., 9: 64.

Photographie de la nébuleuse de la Lyre. il. L'Astron., 9: 441–6. 1890.

Nebula in Orion (Great).

C[ommon] (A. A.) [Note on a photograph by Roberts.] il. Obsry., 12: 105.

Nebula.

Young (C. A.) Note on recent papers of Dr. Huggins. Sid. Mess., 8: 289–91.

Clerk (A. M.) Spectra of the Orion nebula and of the aurora. Obsry., 12: 366–70.

Nutation.

Folie ( ) Détermination de la nutation diurne. Bull. astron., 6: 100–3.

Objectives.

Battermann (H.) Untersuchungen über die Gestalt der Bilder und die Theorie der Messungen ausserhalb der optischen Axe von astronomischen Instrumenten. Astron. Nachr., 120: 337–416.

Steinheil (A.) Einfluss der Objectivconstruction auf die Lichtvertheilung in seitlich von der optischen Axe gelegenen Bildpunkten von Sternen bei zweilinsigen Systemen. Sitzungsb. d. math.-phys. Cl. d. k. bayer. Akad. d. Wissensch., 19 (Hft. 3): 413–15. 1889.

——. Vertheilung des Lichtes in seitlich von der Axe gelegenen Sternbildern und den Einfluss der Construction des Objectives hierauf. Vrtljschr. d. astron. Gesellsch., 24: 254–9. 1889.

Observatories.

Bœhmer (G. H.) Report on astronomical observations for 1886. Smithson. Rept., 1886: 367–483. *Also*, Reprint.

Budget de l'astronomie et de la météorologie [en France 1891]. L'Astron., 9: 436. 1890.

Jahresberichte der Sternwarten für 1888. Vrtljschr. d. astron. Gesellsch., 24: 85–171.

Occultations.

CALLANDREAU (O.) Prédiction des occultations. Bull. astron., 6: 129-41.

Orbits.

GLAUSER (J.) Bahnbestimmung nach Lambert. Astron. Nachr., 121: 65-70.

SEARLE (G. M.) Computation of the true anomaly, radius-vector and coordinates in ellipses of great eccentricity. Astron. Jour., 8: 153-6.

SCHULHOF (L.) Formules différentielles pour les variations des éléments d'une orbite. Bull. astron., 6: 151-192.

Oxford University Observatory.

ASTRONOMICAL observations . . . under the direction of C. Pritchard. No. 3. Researches in stellar parallax by the aid of photography. 8+138 p. 8vo. Oxford, 1889.

Parallax.

VON REBEUR-PASCHWITZ (E.) Hülfstafeln zur Berechnung der Parallaxe für Cometen-und Planetenbeobachtungen. Veröffentl. d. Grossherzgl. Sternwrt. zu Karlsruhe, 3: 183-204. 1889.

Parallax (Solar).

HARKNESS (W.) On the masses of Mercury, Venus, and the Earth and on the solar parallax. Astron. Jour., 9: 9-15, 31.

——. On an error in computation of the solar parallax. Astron. Jour., 9: 5-31.

Parallax (Steller).

BELOPOLSKY (A.) Beitrag zur Ermittelung von Sternparallaxen aus Durchgangsbeobachtungen. Astron. Nachr., 121: 113-28.

FLAMMARION (C.) Distances des étoiles. [Tables.] L'astron., 8: 441-50. 1889.

CLERKE (A. M.) Star distances. Nature, 41: 81.

Paris Exposition (1889).

L'ASTRONOMIE à l'exposition. L'astron., 8: 450.

Paris Observatory.

RAPPORT annuel . . . pour l'année 1888 . . . par [E.] Mouchez. 26 p. 4to. Paris, 1889.

Personal equation.

BAKHUYZEN (H. G. van de Sande). Beschreibung eines Apparates zu der absoluten persönliches Fehlers . . . 40 p., 2 pl. 4to. Haag, 1889.

GONNESSIAT (F.) Recherches sur les erreurs personnelles dans les observations de passages. Bull. astron., 6: 471-80.

LANGLEY (S. P.) Observation of sudden phenomena. Sid. Mess., 8: 291-99.

LOW (M.) Der persönliche Fehler bei Messung von Zenith-Distanzen und Azimuten. Astron. Nachr., 121: 307-16.

Personal scale.

BOQUET (F.) Recherche sur la valeur des observations de passages. Bull. astron., 6: 337-43.

Photographic Congress, Paris (1887).

BULLETIN du comité international permanent pour l'exécution photographique de la carte du ciel. p. 147-286 (3e et 4e fascicule).

[CIRCULAR of International Congress on celestial photography.] Obsry., 12: 329-32.

[REPORTS of meeting of permanent committee on charting, and of organization of committee on celestial photography and spectroscopy.] Obsry., 12: 363-6.

Photography.

MEETING of the permanent committee of the astro-photographic congress. Sid. Mess., 8: 412-14.

PICKERING (E. C.) Photographic determination of the brightness of the stars. Ann. Harv. Coll. Obsry., 18: 119-214 (v. 18, No. 7). *Also*, Reprint.

Photography (Astronomical).

FLAMMARION (C.) Les progrés de la photographie céleste. il. L'Astron., 8: 121–4. 1890.

HOLDEN (E. S.) Photographing and seeing stars in the day-time. Astron. Jour., 9: 73–74.

Photography (Stellar).

ANOTHER photographic chart of the heavens. Obsry., 12: 308–11.

CHARLIER (C. V. L.) Anwendung der Sternphotographie zu Helligkertsmessungen der Sterne. 8+31 p. 4to. Leipzig, 1889.

Pub. d. astron. Gesellsch., 19.

GOULD (B. A.) Reduction of photographic observations, with a determination of the position of the Pleiades from photographs by Mr. Rutherfurd. Mem. Nat'l Acad. Sc., 4: 173–90 (v. 4, 3. mem.). *Also*, Reprint.

KAPTEYN (J. C.) Bericht über die zur Herstellung einer Durchmusterung des südlichen Himmels ausgeführten Arbeiten. Vrtljschr. d. astron. Gesellsch., 24: 213–20.

LA CARTE photographique du ciel. L'astron., 8: 388–91. 1889.

PICKERING (E. C.) Photographic chart of the heavens. Obsry., 12: 375.

RÉUNION du comité international permanent pour l'exécution de la carte photographique du ciel, à l'observatoire de Paris en septembre 1889. 112 p., 4to. Paris, 1889.

Photometry.

SCHAEBERLE (J. M.) Photographic brightness of the fixed stars. Pub. astron. soc. Pacific, 1: 53–64.

SCHEINER (J.) Bestimmung der Sterngrössen aus photographischen Aufnahmen. Astron. Nachr., 121: 49–62.

Planets.

GREGORY (R. A.) Determination of masses in astronomy. Nature, 40: 80.

HALL (A.) Deduction of planetary masses from the motions of comets. Astron. Jour., 9: 47.

Pleiades.

ELKIN (W. L.) Comparison of Dr. Gould's reductions of Mr. Rutherfurd's Pleiades photographs with the heliometer results. Astron. Jour., 9: 33–35.

GOULD (B. A.) Determination of the position of the Pleiades from photographs by Mr. Rutherfurd. Mem. nat'l acad. sc., 4: 173–90. (v. 4, 3. mem.) *Also* Reprint.

Præsepe.

GOULD (B. A.) Reduction of photographic observations of the Pæsepe. Mem. Nat. Acad. Sc., 4: 193–9. (v. 4, 4. mem.) *Also*, Reprint.

Proper motion.

BOSS (L.) Proper motions of stars in the Albany zones. (+0° 50′ to 50° 10′ for 1885.) Astron. Jour., 9: 57–64.

Red stars.

CLERKE (A. M.) Some southern red stars. Obsry., 12: 134.

Refraction.

LÁSKA (W.) Ueber eine einfache Refractionsformel. Astron. Nachr., 121: 111.

LEHMANN-FILHÉS (R.) Eine genäherte Refractionsformel. Astron. Nachr., 121: 383.

RADAU (R.) Essai sur les réfractions astronomiques. 80 p. 4to. Paris, 1889.

Resisting medium.

HALL (A.) Resisting medium in space. Sid. Mess., 8: 433–42.

Saturn.

Anding (A.) Die Seeliger'sche Theorie des Saturnringes und der Beleuchtung der grossen Planeten überhaupt. Astron. Nachr., 121 : 1–16.

Hall (A.) White spot on the ring of Saturn. Astron. Jour., 9 : 23.

Holden (E. S.) Reported changes in rings of Saturn. Astron. Jour., 8 : 180–1.

Keeler (J. E.) Outer ring of Saturn. Astron. Jour., 8 : 22–175.

Lockyer (J. N.) Note on the spectrum of the rings of Saturn. Astron. Nachr., 121 : 15.

Terby (F.) La tache blanche de l'anneau de Saturne . . . Obsry., 12 : 286.

——. Sur l'aspect de la planète Saturne et spécialement sur une tache blanche et brillante observée sur son anneau. il. Astron. Nachr., 121 : 109, 173, 233, 305, 336, 367.

Saturn (Rings of).

Tisserand (F.) Théorie de Maxwell sur l'anneau de Saturne. Bull. astron., 6 : 383, 417.

Solar system.

Boss (L.) Systematic corrections of star positions near Equator, with a note on the constants of solar motion. Astron. Jour., 9 : 17, 25.

Spectrum (Solar).

Janssen (J.) Ascension scientifique au mont Blanc. L'Astron., 9 : 446–9, 1890.

——. Origine tellurique des raies de l'oxygene dans le spectre solaire. L'Astron., 8 : 206. 1889.

Langley (S. P.) The solar and the lunar spectrum. il. Mem. nat. acad. sc., 4 : 159–70. 5 pl. *Also*, Reprint.

Spectra (Stellar).

Espin (T. E.) Stars with remarkable spectra. Astron. Nachr., 121 : 33–6.

Pickering (E. C.) Henry Draper memorial. Third annual report of the photographic study of stellar spectra. 8 p. 4to. Cambridge, 1889.

Star-catalogues.

Auwers (A.) Vorläufiger Fundamental-Catalog für die südlichen Zonen der Astronomischen Gesellschaft. Astron. Nachr., 121 : 145–72.

Berichte über die Beobachtung der Sterne bis zur neunten Grösse am nördlichen Himmel. Vrtljschr., 24 : 280–93. 1889.

Catalogues d'étoiles deduits des observations publiées dans les vols vi et vii. Observations de Poulcova. v. 8. 1889.

Oertel (K.) Beziehungen der in den Berliner astronomischen Jahrbüchern von 1860 bis 1883 gegebenen Fixsternörter zum Fundamental-Catalog der Astronomischen Gesellschaft. Astron. Nachr., 121 : 225–32.

Kreutz (H.) Berichtigungen zu der Bonner Durchmusterungen-Zone 55°–65°. Astron. Nachr., 121 : 23–8.

[Peters (C. H. F.) *vs.* Borst (C. A.) Action to recover manuscript. Supreme court, Oneida Co., N. Y. Opinion of Justice P. C. Williams in favor of Peters.] 19 p. 8vo. Utica, 1889.

Peter's Star-catalogue. Sid. Mess., 8 : 455–58.

[Winlock (A.)] Meridian-circle observations of close polar stars. Ann. Harv. Coll. Obsry., 18 : 259–84. (v. 18, no. 9.) *Also*, Reprint.

Star-charts.

Cottam (A.) Charts of the constellations, London. 1889.

Star-places.

Boss (L.) Systematic corrections of star positions near the Equator, with a note on the constants of solar motion. Astron. Jour., 9 : 17, 25.

Gould (B. A.) Comparisons of the photographic with the instrumental, determinations of star-places. Astron. Jour., 9 : 36–37.

Stars (Motion of) in the line of sight.

VOGEL (H. C.) Ueber die auf dem Potsdamer Observatorium unternommenen Untersuchungen über die Bewegungen der Sterne im Visions-Radius vermittelst der spectrographischen Methode. Astron. Nachr., 121: 241–58.

Sun.

WOLF (R.) Bericht über die Thätigkeit auf der Sonne im Jahre 1888. Astron. Nachr., 121: 107.

——. Statistique solaire de l'année 1888. L'Astron., 8: 61. 1889.

Sun (Diameter of).

AUWERS (A.) Neue Untersuchungen über den Durchmesser der Sonne, III. Sitzungsb. d. k. preuss. Akad. d. Wissensch., 1889: 111–170.

Sun-spots.

BRUGUIÈRE (H.) Maxima et minima solaires. L'Astron., 8: 417. 1889.

SPOERER (G. F. W.) Von den Sonnenflecken des Jahres 1888 und von der Verschiedenheit der nördlichen und südlichen Halbkugel der Sonne seit 1883. Astron. Nachr., 121: 105.

——. Sur les différences que présentent l'hémisphère nord et l'hémisphère sud du soleil. Bull. astron., 6: 60–3.

Tables (Astronomical).

PARKHURST (H. M.) Astronomical tables. 456 p. 16mo. New York, 1889.

Telescopes.

BATTERMANN (H.) Untersuchungen über die Gestalt der Bilder und die Theorie der Messungen ausserhalb der optischen Axe von astronomischen Instrumenten. Astron. Nachr., 120: 337–416.

COMMON (A. A.) Great telescopes. Obsry., 12: 138.

T[ENNANT] (J. F.) Distortion in telescopic images. Obsry., 12: 304–8.

Tempel [Guglielmo Ernesto, 1821–'89.]

SCHIAPARELLI (G. V.) Anzeige des Todes . . . Astron. Nachr., 121: 95.

Thermograph.

HUTCHINS (C. C.) & OWEN (D. E.) Account of a new thermograph . . . measures of lunar radiations. Proc. Am. Acad. Arts Sc., 24: 125–45. *Also*, Reprint, 1889.

Three bodies (Problem of).

BRENDEL (M.) Gylden's theory. Obsry., 12: 399–403.

F[LAMMARION] (C.) Le problème des trois corps. L'Astron., 8: 265–8. 1889.

LIAPOUNOF (A. M.) [Stability of motion in a special case of the problem of three bodies.] 94 p. 8vo. Silberberg, 1889. [In Russian.] *Rev.* by R[ADAU] (R.) Bull. astron., 6: 481–8.

Tides.

FERREL (W.) Laplace's solution of the tidal equations. Astron. Jour., 9: 41–44.

Time services.

OBSERVATORY local patronage threatened. Sid. Mess., 8: 452–54.

Time (Universal).

LA TURQUIE et l'unification du temps. L'Astron., 8: 49. 1889.

Transit instruments.

HAMY (—). Variations de l'axe de rotation des instruments méridiens. Bull. astron., 6: 377–83.

Transit observations (Reduction of).

CHANDLER (S. C.) Note on the equation of the meridian transit instrument. Astron. Jour., 8: 147.

Uranus.

GREGORY (R. A.) The planet Uranus. Nature, 40: 235.

HUGGINS (W.) Spectrum of Uranus. Astron. Nachr., 121: 369.

——. Photographic spectra of Uranus and Saturn. Sid. Mess., 8: 450–52.

LOCKYER (J. N.) Note on the spectrum of Uranus. Astron. Nachr., 121: 369.

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L.O. from E.S.H

PROGRESS OF ASTRONOMY FOR 1891 AND 1892.

BY

WILLIAM C. WINLOCK.

FROM THE SMITHSONIAN REPORT FOR 1892.

WASHINGTON:
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1893.

PROGRESS OF ASTRONOMY FOR 1891 AND 1892.

By William C. Winlock.

A review of the progress of astronomy for the years 1879 and 1880 was contributed by Prof. E. S. Holden to the Smithsonian Report for 1880, and reviews for each succeeding year were continued by him in the annual reports of the Institution up to 1884; the reviews for 1885 and 1886, and for 1887–'88 and 1889–'90 were prepared by the present writer, the publication since 1886 being biennial instead of annual. The arrangement of the review for 1891–'92 is essentially the same as in previous years and, in its compilation as hitherto, notes in recent journals have been freely drawn upon without specific citation.

It should be borne in mind that the review is intended for those having a general interest in astronomy rather than for the professional astronomer who has access to a large working library. To the latter the bibliography appended may be found convenient as a reference, and will supplement the text in giving a general idea of recent publications on any special subject. Many very important papers are of such a nature that they do not lend themselves readily to condensation for the purposes of such a summary as the present.

Within the last few years many new aids have been provided to facilitate reference to the constantly-increasing volume of the literature of the subject. The most comprehensive of these is to be found in the *Bulletin astronomique*, published under the auspices of the Paris Observatory and the able editorship of M. Tisserand. In addition to extensive critical reviews of important memoirs, there is a brief summary of the contributions to other astronomical periodicals, and the whole is made easy of reference by an admirable index (wherein most journals are defective) at the close of the year, which, in fact, to a large extent, supplies a bibliography of astronomy for the year. The *Journal of the British Astronomical Association* contains a summary of current periodical literature, the value of which to the members is abundantly vouched for. The *Publications of the Astronomical Society of the Pacific* contains a great number of admirable reviews or notes, and this department is receiving increased attention in *Astronomy and Astrophysics. The Observatory* has perhaps the most complete notes, without an attempt at a systematic summary of current literature, to be found in English, while the excellent reviews in *Nature* and the more popular notes of the *Athenæum* need no special comment here. The *Astronomische Nachrichten* and the *Astronomical Journal* contain occasional notices of important works.

The "Notes on some points connected with the progress of astronomy during the past year" in the *Monthly Notices* of the Royal Astronomical Society have been increased in scope and fullness, and as the reviews in different branches of astronomy are furnished by specialists, these notes form a most valuable commentary on the year's work. The *Vierteljahrsschrift der astronomischen Gesellschaft* is, of course, the critical astronomical review, and is the recognized authority for summaries of cometary and planetary discoveries.

STELLAR SYSTEMS.

The Milky Way.—The independent researches of Prof. Pickering at the Harvard observatory and of Dr. Gill at the Cape of Good Hope have led to the conclusion that the stars of the Milky Way form a veritable sidereal system, separate and individual. This conclusion is entirely opposed to the views Sir William Herschel reached from his earliest observations (1785) which are still generally received by those who have not given much attention to this special question. Miss Clerke points out in the *Observatory* for September, 1891 (p. 302), that "the study of nebular distribution might alone, and long ago, have driven out of the field every form of 'projection theory' of the Milky Way. For it showed the great majority of gaseous nebulæ to be embraced within its circuit, and this alone amounted to a demonstration that a physical reality, and not simply a geometrical appearance, was in question."

A brief statement of the arguments of Prof. Pickering and of Dr. Gill is contained in a lecture by the latter delivered at the Royal Institution of Great Britain, May 29, 1891. Dr. Gill said:

> I pass now to another recent result that is of great cosmical interest. The Cape photographic star-charting of the Southern Hemisphere has been already referred to. In comparing the existing eye estimates of magnitude by Dr. Gould with the photographic determinations of these magnitudes, both Prof. Kapteyn and myself have been greatly struck with a very considerable systematic discordance between the two. In the rich parts of the sky, that is, in the Milky Way, the stars are systematically photographically brighter by comparison with the eye observations than they are in the poorer part of the sky, and that not by any doubtful amount, but by half or three-fourths of a magnitude. One of two things was certain, either that the eye observations were wrong, or that the stars of the Milky Way are bluer or whiter than other stars. But Prof. Pickering, of Cambridge, America, has lately made a complete photographic review of the heavens and by placing a prism in front of the telescope he has made pictures of the whole sky. . . . He has discussed the various types of the spectra of the brighter stars, as thus revealed, according to their distribution in the

sky. He finds thus that the stars of the *Sirius* type occur chiefly in the Milky Way, whilst stars of other types are fairly divided over the sky.

Now stars of the *Sirius* type are very white stars, very rich relative to other stars in the rays which act most strongly on a photographic plate. Here then is the explanation of the results of our photographic star-charting, and of the discordance between the photographic and visual magnitudes in the Milky Way.

The results of the Cape charting further show that it is not alone to the brighter stars that this discordance extends, but it extends also, though in a rather less degree, to the fainter stars of the Milky Way. Therefore we may come to the very remarkable conclusion that the Milky Way is a thing apart; and that it has been developed perhaps in a different manner, or more probably at a different and probably later epoch from the rest of the sidereal universe.*

NEBULÆ.

In a paper by Prof. Keeler, communicated to the Royal Society by Dr. Huggins on March 19, 1891, the question of the position of the chief nebular line seems to be definitely settled. Prof. Keeler has not only made a series of sixteen complete measures, obtained on eleven nights, of the chief line in the spectrum of the Orion nebula, thus defining its apparent position when corrected for the earth's motion, as λ 5006.22 ± 0.014, but has supplemented these by ten measures of the green hydrogen line on seven nights. The latter show the nebula to be moving relatively to the solar system with a motion of + 10.7 ± 1.0 miles per second, and oblige us to fix the true position of the chief line at λ 5005.93. The chief line is therefore 0.43 tenth meter more refrangible than the lower edge of the magnesium fluting, and as it has no resemblance to a fluting in appearance, and as flutings and lines of magnesium, which could not fail to appear at the same time with the fluting at λ 5006.36 are entirely absent from nebular spectra, the incorrectness of the view that the nebular line is the remnant of the magnesium fluting appears to be demonstrated.

Mr. Burnham has made a set of measures of the nebula in the Pleiades close to the star Merope. He remarks that it is one of the most singular and interesting objects in the heavens. With respect to its nearness to a bright naked-eye star (the distance between the centers is less than 40″) it is unique. There may be other examples, but certainly no other has ever been discovered, and this close association of a faint nebula and one of the prominent stars of the Pleiades is an interesting fact, whether such association is accidental or otherwise. The accurate measures made by Mr. Burnham and Mr. Barnard will enable this point to be ascertained when others shall have been made sometime hence, and it will be possible to determine by comparison whether the new nebula is drifting in space with Merope and the other stars of this famous group. We have, of course, many examples of large stars involved in widely diffused and extended nebulous masses, but no instance has hitherto been known of a star bright enough to be visible to the naked eye having a small definite nebula within even several times the distance of this from Merope.

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*Publications of the Astronomical Society of the Pacific, 19.

ASTRONOMICAL CONSTANTS.

The Constant of Aberration.—Prof. Comstock, of the Washburn Observatory, has been making careful trial of a modification of the method of determining the constant of aberration first suggested by M. Loewy. The essential feature of M. Loewy's method is the introduction of reflecting surfaces in front of the objective of a telescope, by means of which images of different portions of the heavens are simultaneously produced in the focal plane of the objective. By means of the micrometer the apparent distance between the images of two stars thus produced may be measured, and the angular distance between the stars determined from a simple relation involving the measured quantity and the angle included between the reflecting surfaces. It is obvious that great difficulties would attend the determination of this angle, and M. Loewy avoids these difficulties by measuring the distances of two pairs of stars and taking the difference of these distances, thus eliminating the angle between the mirrors. Prof. Comstock has found it advantageous to place before the objective three reflecting surfaces instead of two, making approximately equal angles among themselves, and to employ successively each pair of surfaces in measuring the distance between two given stars. If the normals to these surfaces all lie in the plane passing through the two stars and the earth, the mean of the three dihedral angles formed by the surfaces will be exactly 120°; and by taking the mean of the results furnished by the three pairs of surfaces the distance between a pair of stars may be determined independently of the angles between the mirrors. Prof. Comstock's provisional result for the constant of aberration is $20''.494 \pm 0''.017$.

MM. Loewy and Puiseux's work on the Constant of Aberration is summarized as follows in a communication to the *Comptes Rendus* for March 16, 1891.

1. Struve's value $20''.445$ is very near the truth. It would, in our opinion, be premature to alter it.
2. M. Fizeau's result, that reflection does not affect the behavior of rays with regard to aberration, is confirmed.
3. The new method for determining aberration can be regarded as satisfactory and definitive.

STAR CATALOGUES AND CHARTS.

The Star Catalogue of the Astronomische Gesellschaft.—The zone undertaken by the Harvard College Observatory +50° to +55° declination has been published as the fifth part of the great catalogue. The observations were made with the new meridian circle in the years 1870–'78 and 1883–'84, chiefly by Prof. W. A. Rogers, under whose direction the reductions have also been made. The right ascensions were observed chronographically over eleven vertical wires, and the declinations also chronographically over an inclined wire, the circle being read by two microscopes. The probable error of an observation in 1870–'78 is ±0.ˢ054 in right ascension and ±0″.55 in declination, and is rather greater for stars fainter than the eighth magnitude than for brighter stars.

The fifth volume of the Annals of the Leyden observatory contains the second half of the zone observations between +30° and +35°—embracing ten thousand observations.

The Paris Catalogue.—The second part of this work, containing the places of stars from 6^h to 12^h of right ascension, has recently been issued, the first part having been published in 1887. There are really three catalogues, the first comprising observations from 1837 to 1853 reduced to 1845.0; the second, those made from 1854 to 1867 reduced to 1860.0, and the third from 1868 to 1881 reduced to 1875.0. The stars are arranged in the order of right ascension at 1875.0. A valuable memoir on the proper motions of the stars contained in the catalogue has been prepared by Bossert.

Second Munich Catalogue.—A second catalogue, containing 13,200 stars for the epoch 1880.0 has been published under the direction of Prof. Seeliger supplementary to the larger catalogue recently issued. The stars are from the seventh to tenth magnitude within 25° of the equator, and were observed with the meridian circle during the years 1884 to 1888. The positions depend upon Auwers's Fundamental Catalogue.

Pulkowa Catalogue.—The Pulkowa catalogue of 5,634 stars for 1875 is deduced from observations made with the meridian circle during the years 1874–'80, and prepared for publication by Herr Romberg. The stars are of various classes, including many of the Struve double stars. A comparison is made with the places of several other catalogues.

Oeltzen's Catalogue.—A new editon of Oeltzen's catalogue of Argelander's southern zones, —15° to —31°, has been published by Prof. Weiss. The total number of stars is 18,276, the positions being given for 1850.0 with the amount of the precession necessary to bring them to 1875.0. The places of stars north of —23° have been compared with Schönfeld's Southern Durchmusterung, and south of that limit with other catalogues, thereby eliminating a considerable number of errors from the original places.

Bœddicker's map of the Milky Way.—Dr. Bœddicker, of the Earl of Rosse's observatory at Birr Castle, has been at work since 1884 upon an elaborate map of the Milky Way from the North Pole to 10° south declination, and has at length finished this very laborious task. His plan has been to exhibit the ramifications of the Milky Way as it appears to the naked eye, a necessary first step to the knowledge of the structure of the sidereal universe. No optical help has been used.

STELLAR PARALLAX.

Prof. Pritchard has continued in Part IV of the publications of the Oxford University Observatory his work upon the photographic determination of stellar parallaxes. He has concluded "from actual and prolonged experience that an accuracy, amply sufficient in the present condition of astronomy, is secured by observations of each star made on twenty-five nights advantageously selected throughout the parallactic year, four exposures being usually made on each night."

The general result of the investigations of the parallax of thirty northern stars of the second magnitude is that the average parallax of a star of the second magnitude is 0.″056; and comparing with this the result of Drs. Gill and Elkin for the average parallax of fourteen first magnitude stars, viz, 0.″089 we see that there is distinct evidence that the brighter stars are nearer—though it should be borne in mind that the heliometer was used by Drs. Gill and Elkin, and the photographic method by Prof. Pritchard.

Following is a tabular statement of the Oxford results. Two results *a* and *b* are obtained, from two comparison stars; the probable error of each result is about ±0.″025:

Star.	Parallax.	
	a	*b*
	″	″
α Andromedæ	+0.0565	+ 0.0600
β Andromedæ	+ .0610	+ .0860
α Arietis	+ .0880	+ .0715
α Persei	+ .0996	+ .0738
β Persei	+ .0642	+ .0529
β Tauri	+ .0736	+ .0529
β Aurigæ	+ .0591	+ .0652
γ Geminorum	— .0135	— .0333
α Ursæ Majoris	+ .0486	+ .0436
β Ursæ Majoris	+ .1177	+ .0434
γ Ursæ Majoris	+ .0768	+ .1206
ε Ursæ Majoris	+ .0832	+ .0792
η Ursæ Majoris	— .0309	— .0628
β Leonis	+ .0490	+ .0087
β Ursæ Minoris	— .0200	+ .0644
α Coronæ	— .0255	— .0493
γ Draconis	+ .0625	+ .0371
γ Cygni	+ .1107	+ .0931
ε Cygni	+ .0927	+ .1629
α Pegasi	+ .0913	+ .0719
ε Pegasi	+ 0693	+ .0919

Yale heliometer determinations of stellar parallax.—Dr. Elkin publishes the following preliminary results of his investigations of the parallaxes of the first magnitude stars in the northern hemisphere, proposing to continue his observations until he has secured one hundred sets of measures of each of the ten stars—that number being required in his opinion to furnish parallaxes with probable errors not much above 0″.01:

Star.	Parallax.	Probable error.	No. of comparison stars.	No. of sets.
	″	″		
α Tauri	+0.101	±0.022	6	65
α Aurigæ	+0.095	0.021	5	51
α Orionis	+0.022	0.022	6	48
α Canis Minoris	+0.341	0.020	6	48
β Geminorum	+0.057	0.021	6	48
α Leonis	+0.089	0.026	10	43
α Bootis	+0.016	0.018	10	80
α Lyræ	+0.092	0.019	6	67
α Aquilæ	+0.214	0.023	10	46
α Cygni	—0.012	0.020	7	49

Determination of stellar parallax with a transit instrument.—Prof. Kapteyn has published a paper of much interest, upon the determination of relative stellar parallax by observations of the differences of right ascension between the selected star and neighboring comparison stars made with the transit instrument and chronograph. The comparison stars are selected of about the same declination as the star whose parallax is to be determined and symmetrically situated at slightly greater and less declinations. The differences of right ascension and of magnitude should be small. Special precautions are taken to eliminate all ordinary instrumental errors, particularly the error of clock rate, which has an important effect.

The following are the results published by Prof. Kapteyn. The probable error given in each case is not far from ±0.″03:

Star.	Parallax.	Star.	Parallax.
	″		″
Bonn VII 81	+0.074	*Bonn VII* 104	+0.428
θ Ursæ Majoris	+ .052	105	+ .168
Bonn VII 85	+ .064	110	+ .030
20 Leo Minoris	+ .062	111	+ .016
Bonn VII 89	+ .176	112	+ .139
Bonn VII 94	+ .101	114	+ .038
Bonn VII 95	+ .038	119	+0.056
Lal. 20670	—0.011		

Parallax of δ Herculis.—Prof. Leavenworth has found a parallax of +0.″050 ±0.″014 from his own observations of this star; and from a series of observations published by Dembowski in his "Double Star Observations," +0.″030 ±0.″015.

Parallax of P Ursæ Majoris.—Dr. Franz finds from heliometer observations of this star at Königsberg from 1883 to 1890 a parallax of

+0.″10 with a probable error of 0.″01. As the annual proper motion is 3″, this parallax implies that the star is moving through space at a rate of 88 miles a second. Dr. Franz's result is considerably smaller than that obtained by Prof. Geelmuyden from transit observations, π=0.″27 from differences of right ascension, and 0.″24 from differences of declination.

DOUBLE AND MULTIPLE STARS.

Gore's catalogue of binary stars.—Mr. Gore has compiled a useful catalogue of binary stars, for which orbits have been computed, giving, besides the elements, date of computation, etc., the magnitudes, colors, spectra, hypothetical parallax, observed parallax, relative brightness, and the constants A and B for use in Mr. Rambaut's method of computing the parallax from the orbital motion of the star in the line of sight. The more recent measures are given in a series of notes. The catalogue was originally communicated to the Royal Irish Academy, in June, 1890, and has been reprinted from the Proceedings.

Prof. Asaph Hall has made a further discussion of the relative motion of the two components of 61 Cygni and the question whether there is anything in the nature of a physical connection between the two. His conclusion is in favor of such connection, but although accurate observations of the mutual distances and angles of position date from 1825, and Prof. Hall includes in the discussion those made by himself up to 1891, it is not possible to reach any result with regard to the period of revolution, except that it is long.

Two lists of double stars discovered by Mr. Burnham, most of them with the 36-inch refractor, have appeared during 1892, bringing Mr. Burnham's double star discoveries up to 1264. Most of his measures are of the more difficult or interesting doubles, a measurement of 0″.1 being apparently quite a simple matter. Mr. Burnham has also published a number of investigations of double star orbits, and collected lists of measures.

Among lists of recently published measures of double stars should be mentioned the series of observations of 950 stars by Prof. Hall made from 1880 to 1891, with the 26-inch equatorial, of the United States Naval Observatory. With reference to the reduction and discussion of double star measures, Prof. Hall says: "The formulæ and corrections for personal equation of observation seem to me of doubtful utility, and a better way is to compare the measurements of the same star by different observers."

Discovery of double stars by means of their spectra.—In the review of astronomy for 1889–'90 attention was called to Prof. E. C. Pickering's discovery of the duplicity of ζ Ursæ Majoris and β Aurigæ through pecularities in their spectra which indicated differences in the motions of supposed components.

Prof. Pickering has more recently called attention to another interesting class of "invisible double stars," detected in a somewhat similar way by peculiarities in their spectra.

Of many double stars the brighter component is red or yellow, while the fainter component is green or blue. The spectroscope shows that this is due to the fact that the spectrum of the brighter component is of the second type, like our sun, while the spectrum of the fainter component is of the first type, traversed by strongly marked hydrogen lines. If the stars are near together the spectrum of the combined light resembles that of the sun, except that the hydrogen lines are all strong. Stars like β Cygni give such a spectrum, but the components are so far apart that the separation of their spectra is clearly shown. Several stars hitherto supposed to be single have been found whose spectrum is of the class described above, and the question arises whether they may not really be double with components so close that they can not be separated by ordinary means. In the detailed examination of the spectra of the brighter stars made by Miss Maury upon the Harvard photographs, stars occupying all intermediate grades from the first to the second type have been found, and it is difficult to determine whether there are really two spectra or merely changes in the spectrum of a single star due to physical causes. Upon the hypothesis of duplicity the hydrogen lines would probably show a periodic displacement, and in fact an examination of four photographs of the spectrum of Procyon does show a displacement of the lines which, if the phenomenon is due to the relative movement of a faint component, would seem to indicate that it is receding at the rate of 20 kilometers per second as compared with the bright component. The evidence of duplicity is not considered conclusive by Prof. Pickering, but, from an examination of ten other stars having a similar composite spectrum, five are well-known doubles, two have distant companions, leaving three, τ Persei, ζ Aurigæ, and δ Sagittarii, which it would seem from the above considerations may possibly be double.

VARIABLE STARS.

Algol.—Mr. Chandler has published the results of an interesting investigation of the variable star Algol, the periodicity of which appears to have been first discovered by Goodricke, at York, in 1782; and the explanation suggested by him of the periodic diminution of the brightness, that it is produced by the interposition of an opaque satellite, is now generally accepted, confirmed as it has recently been, by the investigations of Prof. Vogel. Mr. Chandler, after an elaborate investigation of the inequalities in the period, and also of the irregularity in the observed proper motion of Algol, has found that they may be satisfactorily accounted for by supposing that both Algol itself and the satellite which revolves round it in about 2 days 20.8 hours have a common revolution round a third, large, distant and opaque body, in a period of about 130 years. The size of this orbit around the common center of gravity is about equal to that of Uranus around the sun. The plane of the orbit is inclined about 20° to our line of vision.

Several interesting cases of variability have been detected in the examination of the photographs of stellar spectra at the Harvard Observatory all showing the bright hydrogen lines; the change in brightness exceeding two magnitudes. The director of the Harvard Observatory has called for the coöperation of astronomers provided with telescopes of moderate power and not otherwise engaged, for the observation of a list of seventeen circumpolar variables of long period. The methods to be followed are set forth in a circular issued by the observatory, and accessible to all who are interested.

Nova Auriga—One of the most remarkable outbursts of "new stars" or "*nova*" that has ever been recorded, occurred during the year 1892—a phenomenon of double interest in that it afforded an opportunity of study under improved astronomical apparatus.

On February 1, 1892, an anonymous postal card was received at the Royal Observatory, Edinburgh, announcing the presence of a new star in the constellation Auriga. It subsequently turned out that the discoverer was Dr. Thomas S. Anderson, an amateur astronomer living in Edinburgh, that the discovery had been made by the help of a star-atlas and a small pocket telescope, and that the star had been seen by him for some days previous to February 1; it was of about the fifth magnitude. In the first observations at Edinburgh it was found to be of a yellow tint and about the sixth magnitude, its position for 1892 being right ascension $5^h\ 25^m\ 3^s$; declination $+30°\ 21'$. Very fortunately systematic photographs of this region had been made for some time by Prof. Pickering at the Harvard Observatory, and the *Nova* was in fact found to have been photographed on thirteen plates taken between December 10, 1891, and January 20, 1892; while it does not appear upon a plate taken at Heidelberg on December 8, which shows stars down to the ninth magnitude. The outburst, at least above the ninth magnitude seems, therefore, to be pretty well fixed between December 8 and 10, 1892.

The Nova remained of the fourth or fifth magnitude till the end of February, then diminished somewhat rapidly, and by the end of March it was of the twelfth to fourteenth magnitude.

In August it was again easily visible. At the Lick observatory it was found to be of 10.5 magnitude on August 17, and 9.8 on August 19, and further fluctuations in brightness have occurred.

The spectrum was of the greatest interest. The chief characteristic was a brilliant array of bright, broad lines, attended by dark companions on the more refrangible sides. Numerous finer details were then added, dark lines crossing the broad, bright bands, and bright lines marking the dark companions.

Three lines have attracted more especial attention on account of their intimate connection with the suspected physical constitution of the star. "These are (1) the bright-green line near b_4, and the less refrangible edge of the hydrocarbon band; (2) the line near the chief nebular line λ5006, and (3) the line near the pair of chromospheric lines λ4923 and λ4921. When the wave length of these lines, as quoted by the observers, are corrected for motion in the line of sight, and arranged in a table, the mean values come out very close to the wave lengths of three notable pairs of solar chromospheric lines; while magnesium and the hydrocarbons, as possible origins of line (1), are excluded by the absence from the lists of their inseparable companion lines and flutings.

Line (2) is claimed by four observers for the chief nebular line, but the weight of evidence seems to be against its nebular origin, and the outburst would seem to be a vast chromospheric disturbance, a view confirmed by Dr. Huggins' observation of the complete series of bright hydrogen lines in the ultra-violet—the same that Hale and Deslandres found in the solar chromosphere—but each with its dark companion.

An interesting article advocating the meteoric theory in explanation of the outburst is given by Prof. Lockyer in Volume 31 of the Nineteenth Century. The chromospheric theory of the near approach of two stars is given by Dr. Huggins in the June number, 1892, of the Fortnightly Review; Seeliger's modification of the meteoric theory is translated in Astronomy and Astrophysics for December, and a single-star chromospheric theory is offered by Sidgreaves in the October number of the Observatory.

STELLAR SPECTRA.

Draper catalogue of stellar spectra.—Volume 27 of the Harvard Annals contains a catalogue of the photographic spectra of more than ten thousand stars north of 25° south declination. The photographs were taken with an 8-inch Voigtländer lens, in front of which was placed a prism 8 inches square, with a refracting angle of 13°. The edge of this prism was so fixed that the star's light was dispersed in declination, the length of the spectrum being about a centimeter, and the star being allowed to trail slightly gave the spectrum a width of about a millimeter. Each plate covered 10° square and the spectra of all stars to the sixth magnitude were photographed. The spectra are divided, for convenience, into a large number of classes—A B C D indicating varieties of the first type; E to L, varieties of the second type; M, the third type; N, the fourth type; and O P Q spectra that do not resemble any of the preceding types. One of the most important features of the work is the method by which photographic magnitudes have been assigned. "The quantity measured in each case is the intensity of the spectrum in the vicinity of the G line. Accordingly, when stars having different spectra are compared, the results will not be the same as if the entire light of the stars were measured. In the latter case, the results will differ with the color of the star, according to the method of measurement employed. This is a serious defect in the measures of the brightness of the stars in catalogues hitherto published. Since the present measures relate to rays of a single wave-length, the same result should be obtained whether the method of comparison was by the photographic plate, the eye, or the thermopile."

The Draper catalogue gives the approximate positions of the stars for the year 1900, with their reference numbers in the Bonn Durchmusterung and the Harvard Photometry; their class of spectrum by letters; their photographic magnitudes and the differences of these from the magnitudes of the Durchmusterung, the Argentine General Catalogue and the Harvard Photometry. A well arranged table gives the details of the measures of magnitude on the various plates on which each star appears. The whole sky to 25° south declination was photographed twice with plates overlapping.

Volume 26, part 1, of the Harvard Annals gives additional details respecting the photographs, their measurement and reduction not conveniently included in the catalogue volume itself—a complete history of the Draper Memorial. A point brought out in the various matters discussed in this volume is the predominance of the first type spectra in the Milky Way elsewhere referred to, and the systematic undervaluing of the brightness of the Galactic stars by about one-fifth of a magnitude, by the "Durchmusterung" and "Uranometria Argentina" as compared with the Harvard photometric and photographic magnitudes.

A third volume is to follow devoted to the work of the 8-inch Draper telescope during the years 1889 and 1892 and to the discussion of stars of peculiar spectra.

A fifth type of stellar spectra.—Prof. E. C. Pickering has proposed to class in a "fifth type" stars whose spectra resemble those of the stars discovered by Wolf and Rayet. In general, his photographic survey has confirmed Secchi's fourfold division of stellar spectra, but many stars in Orion and the neighborhood differ considerably from the ordinary first-type stars, the additional lines, instead of being faint as in Vega, being nearly as intense as the hydrogen lines, while two classes of objects, the planetary nebulæ and the stars, the spectra of which consist chiefly of bright lines, are left unprovided for. Prof. Pickering points out the close similarity of the grouping of the lines in these three classes and also the striking character of their distribution. While stars of the second and third types are about equally divided between the Milky Way and the regions remote from it, two-thirds of the first-type star lie in or near the Milky Way and of the Orion stars four-fifths are found in the Milky Way.

A similar distribution of the planetary nebulæ has long been recognized, and Prof. Pickering shows that, of thirty-three stars known as the "Wolf-Rayet," or as he suggests the "fifth type," every one lies within 10° of the Galactic equator, two-thirds within 2° of it.

α Virginis.—Dr. Vogel's more recent observations of α Virginis at Potsdam accord with his earlier observations of the same star, showing that it is a close binary. The method of observation is quite interesting: The spectrum of the star and of terrestrial hydrogen are photographed together, and the displacement of the star lines on the photograph in the neighborhood of H γ is afterwards measured under a microscope. Stars with spectra of the second and third types give results of considerable accuracy, as the lines in such stars are numerous and sharp.

In the case of α Virginis the difficulties of observation were greater, the hydrogen lines being broad and diffuse, without any definite maximum of intensity, and there were no distinct lines in the vicinity of H γ to which the measurements could be referred. Dr. Vogel's measurements of twenty-four photographs showed that the star lines were displaced alternately toward the upper and the lower end of the spectrum in a complete period of about four days, the maximum displacement toward the violet indicating a motion of the star toward the sun of 65.9 English miles, and that toward the red a receding motion of 47.5 miles per second. These observations are completely explained by supposing that *Spica* is a binary star having a period of one component about the other or the common center of gravity of about 4 days, (the orbital velocity of the larger component being 56.7 miles per second) and that the system is approaching the sun at the rate of 9.2 miles per second. On the assumption of a circular orbit, equal mass of the components, and the data given by observation, the mass of the system is 2.6 times that of the sun, and the distance between the components 6,260,000 miles.

In commenting upon Dr. Vogel's work Prof. Keeler says, "A wonderful picture of stellar motion is presented to our mind, and one to which the whole visible universe as revealed to us by our greatest telescopes offers no parallel. The spectacle of two great suns like our own, revolving around each other in only four days, at a distance no greater than that which separates the sixth satellite of Saturn from its primary, is one which the inadequacy of our optical powers will probably ever forbid us from actually beholding, but the indirect evidence that such extraordinary circumstances of motion exist is so complete that we must admit their reality."

β Auriga.—The Potsdam observations furnish a complete confirmation of Prof. Pickering's discovery of the duplicity of this star. The lines in the spectrum of the star appear double on every second day, and the component, in the line of sight, of the motion of the system can amount to nearly 150 miles a second, while the whole system has a motion relatively to the solar system of −4.03 miles; that is, a motion of this amount per second towards the solar system.

ζ Ursæ Majoris.—The duplicity of ζ Ursæ Majoris is not so satisfactorily confirmed. The maximum relative velocity of its two components seems to amount to about 100 miles per second.

α Bootis.—Mr. Keeler's recent measures upon the D line of the spectrum of *Arcturus* show that the velocity in the line of sight is not 80 kilometers per second, the value hitherto accepted, but 6.4 kilometers, which accords with the result obtained by Dr. Vogel. The mean of the measures at Potsdam from October 5, 1888, to May 23, 1890, is −7.1 ± 0.3 kilometers. The Lick observations from April 20, 1890, to August 15, 1890, give −6.9 kilometers.

ASTRONOMICAL PHOTOGRAPHY.

The photographic chart of the sky.—The third* meeting of the permanent committee, appointed by the Astrophotographic Congress at Paris in 1887, was held at the Paris observatory from March 31 to April 4, 1892. Admiral Mouchez presided, the members of the committee present being Baillaud, Bakhuyzen, Beuf, Christie, Denza, Donner, Gill Henry (Paul), Henry (Prosper), Janssen, Kapteyn, Loewy, Mouchez, Pujazon, Rayet, Ricco, Tacchini and Trépied. The following astronomers were also present by invitation, Messrs. Abney, Andoyer, Belopolsky, Bouquet de la Grye, Cornu, Knobel, Gautier, Maturana, Plummer, Scheiner, Tisserand, and Wolf (C).

Drs. Bakhuyzen and Gill were elected vice-presidents and Prof. Kapteyn and Trépied secretaries.

From reports of progress made at different observatories the following notes indicate the advancement of the work:

Some delay had been experienced in securing the plates containing the reference lines or "*réseaux*," but provision was finally made to furnish them at an early day, as well as the photographic plates which it was necessary should be of a specially good quality of plate glass.

Algiers.—Instruments ready and only awaiting the plates and "*réseau*."

Bordeaux.—Photographic installation has been ready for about a year; a number of experimental photographs have been taken and the work can commence as soon as a supply of plates is secured with the necessary "*réseau*."

Cape of Good Hope.—Instrument practically ready.

Catania.—The instrument has been completed.

Helsingfors.—The instrument has been ready for several months and a considerable number of photographs have been taken.

La Plata.—Instrument ready.

Melbourne.—Instrument ready and a number of experimental plates have been secured.

Oxford.—Instrument ready and a number of plates submitted to the committee.

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* The first meeting of the committee, for organization, etc., was held at the time of the Congress in April 1887, the second meeting or the first regular meeting for discussions, in September, 1889 (not 1890, as stated by a misprint in the review of Astronomy for 1889-'90).

Paris.—Instrument ready.

Potsdam.—Instrument ready and a number of plates submitted to the inspection of the committee.

Rio de Janeiro.—The photographic equatorial has been received and will be mounted at the new site of the observatory.

Rome (Vatican).—The instrument has been completed.

San Fernando.—The instruments are mounted and work can be begun as soon as the *réseau* is received.

Santiago.—The instrument is finished, but, owing to political disturbance in Chile it is impossible to fix a day for beginning the work.

Sydney.—Ready except for the "*réseau.*"

Tacubaya.—Instrument ready and a number of experimental plates submitted.

Toulouse.—The instrument was one of the first to be mounted; the "*réseau*" and photographic plates are only needed to begin the work.

Following is a summary of the resolutions adopted at this meeting:

(1) No change is made in the conditions of distance and magnitude of the stars that have formed the different parts of the catalogue of guide stars.

If, however, the guide star of the catalogue is not bright enough, a brighter one may be selected up to a distance of 40′ from the center of the plate.

(2) The "*réseau*" is to be photographed upon each plate by parallel rays of light. (To replace resolution 15 adopted at the meeting of 1889.)

(3) The orientation of the plates in zones above 65° declination will be arranged for the equinox of 1900; for other stars the parallel will be referred to the apparent equinox.

(4) The work decided upon by the congress of 1887 comprises two series of negatives made with different exposures. The committee, while urging special activity in securing plates of shorter exposure (negatives intended for the catalogue), would suggest that the best nights be also taken advantage of for plates of longer exposure (for the chart).

(5) Negatives from which the catalogue is to be formed will have two exposures for the same plate, one showing faintly the images of stars of the eleventh magnitude, the other with an exposure twice as long, the distance of the two images being 0.2 to 0.3 of a millimeter. (To replace resolution 23 of the meeting of 1889.)

(6) MM. Abney and Cornu are added to the committee on reproduction of the negatives.

(7) With reference to the production of the chart, purely photographic methods will be used, to the exclusion of all manual intervention.

(8) For the chart proper (long exposures) a series of negatives with single exposure will be taken, having an *even* degree of declination in the center of the plate. Further study will show whether it is desir-

able that in the second series (those with an *odd* degree at the center) there should be two or three exposures.

(9) To make it possible to pass uniformly and with certainty from Argelander's ninth magnitude to the eleventh magnitude desired for the negatives of the photographic catalogue there will be distributed among the observatories fine wire-gauze screens, absolutely identical, which, when placed over the object glass of the telescope will diminish the magnitude of a star by two units (adopting the coefficient 2.512 for the ratio between two consecutive magnitudes). Each observatory will from time to time make type negatives of certain specified regions.

(10) The committee suggests forty minutes as the length of exposure of the plates for the chart (the series of *even* declinations) under the ordinary atmospheric conditions of Paris, and with the Lumière plates used.

The committee on metallic screens will furnish the Messrs. Henry with a screen with which they will determine the time *t* for obtaining the eleventh magnitude stars of Argelander's scale. Then for each observatory provided with an identical screen, the ratio 40 :t will be the factor by which to multiply the time of exposure necessary to secure satisfactory images of eleventh magnitude stars, in order to obtain the proper exposure for the chart plates.

(11) The questions of the number of reference stars for each negative for the catalogue, the choice of the stars, and the necessary steps to secure meridian observations are referred to a special committee, consisting of Messrs. Auwers, Bakhuyzon, Christie, Ellery, Gill, Kapteyn, and Loewy, with full powers.

(12) As soon as convenient each observer will prepare, or will have prepared by any observatory or bureau he may select—

(*a*) Measures of the position of each star on the catalogue referred by rectilinear coördinates to the nearest lines of the "*réseau.*"

(*b*) Measures necessary for the determination of the stars' magnitudes.

The different observatories will publish the separate results of these measures and the Permanent Committee will undertake their reduction as soon as a sufficient number of meridian observations of the reference stars is at hand.

(13) The work upon the chart will commence at each observatory as soon as the metallic screen reducing the stars by two magnitudes is received, involving probably a delay of two months. Each observer may, however, begin before receiving the screen if he is confident that he can get all stars of the eleventh magnitude upon the catalogue plates.

(14) Without adopting a formal resolution, the committee would recommend as a separate and personal investigation, that a special series of negatives with long exposures be made of the region near the ecliptic.

The following distribution of the zones among the different observatories was definitively adopted in place of that previously published:

Observatories.	Latitude.		Zone.		No. of plates.
	°	′	°	°	
Greenwich	+51	29	+90 to	+65	1149
Rome	+41	54	+64	+55	1040
Catania	+37	30	+54	+47	1008
Helsingfors	+60	9	+46	+40	1008
Potsdam	+52	23	+39	+32	1232
Oxford	+51	46	+31	+25	1180
Paris	+48	50	+24	+18	1260
Bordeaux	+44	50	+17	+11	1260
Toulouse	+43	37	+10	+ 5	1080
Algiers	+36	48	+ 4	— 2	1260
San Fernando	+36	28	— 3	— 9	1260
Tacubaya	+19	24	—10	—16	1260
Santiago	—33	27	—17	—23	1260
La Plata	—34	35	—24	—31	1360
Rio de Janeiro	—22	54	—32	—40	1376
Cape of Good Hope	—33	56	—41	—51	1512
Sydney	—33	52	—52	—64	1400
Melbourne	—37	50	—65	—90	1149

(16) Every year before the end of January a report upon the progress of the work will be made to the bureau of the Permanent Committee.

(17) The thanks of the conference were voted for the courtesy of the Academy of Sciences in printing the Bulletin, and the hope was expressed that the different governments would provide the necessary means for the observations themselves and for the publication of the chart.

The sixth fasciculus of the Bulletin contains papers by Prof. Kapteyn and M. Sautier on the parallactic micrometer, and upon photographic magnitudes by Profs. Wolf and Dunér. The latter subject has also been discussed by Dr. Scheiner in the *Astronomische Nachrichten,* by Prof. Pritchard in the *Comptes Rendus,* and by Mr. Christie in the *Monthly Notices.*

Photographs of the Pleiades.—Rutherford's photographs of the Pleiades taken in 1872 and 1874 have been selected for measurement by Mr. Jacoby as offering an opportunity for comparing the accuracy of the photographs with that of heliometer and micrometer measures. Each plate contains two impressions of the cluster, both of which were measured. Mr. Jacoby's method consisted of measuring the position angle and distance from the star 24 *p*, and he finds the probable error of the mean of the twenty exposures to be about ± 0.″03 in each element.

A comparison between these photographic places and the places resulting from the Yale and Königsberg heliometers shows that the photographs are fully entitled to be taken into consideration in making a study of the proper motions or in forming a definitive catalogue of the group.

Dr. Max Wolf, of Heidelberg, with a portrait lens of 2½ inches aperture, has not only discovered new nebulæ on his long exposure photographs, but new minor planets; several meteors which crossed the field left perfectly distinct records.

COMETS.

In a series of papers in the *Bulletin Astronomique* M. Schulhof has developed in an interesting way the relations existing between the elements of a comet's orbit before and after it suffers perturbation by a planet. That the periodic comets of our system have been captured through the perturbing action of planets appears established; and Mercury has four comets assigned to it, Venus seven, the Earth ten, Mars four, Jupiter twenty-three, Saturn nine, Uranus eight, Neptune five, and a further group of comets appears to give a feeble indication of an ultra-Neptunian planet at a distance from the sun of about seventy times that of the earth.

The search for new comets has been systematized by the cometary section of the British Astronomical Association under the direction of Mr. W. F. Denning. The aims of this section are to secure observations of comets, to discover new comets and nebulæ, to record telescopic meteors, etc. It is intended to sweep the sky regularly for new comets, a definite region being assigned to each observer according to convenience and choice.

The following notes, relating chiefly to the comets of 1891 and 1892, will complete the list of comets published in these "Reports of Progress," from 1883 to 1892. It is hardly necessary to remark that the most complete and authoritative annual summary of cometary phenomena is that published by Dr. Kreutz in the *Vierteljahrsschrift der Astronomischen Gesellschaft*.

The arrangement adopted below is the order of perihelion passage, except in the case of well-known periodic comets, such as Encke's, Winnecke's, etc., which are arranged alphabetically by their recognized names. The table of elements appended is to be regarded as only approximate, but is sufficient to furnish an idea of the general form and position of the orbit.

Comet Encke:
=Comet 1891, III.

The return of Encke's well-known periodic comet; first found by Barnard, from the ephemeris, on August 1, 1891. It was then exceedingly faint, but in September it had increased to a nebulous mass of about the sixth to seventh magnitude. The comet was unfavorably situated for observation after the end of September, the last observation reported being October 11. It is noteworthy that its path at this return was almost the same as in the return of 1858, and a comparison of the brightness on these two occasions would seem to indicate that it has not undergone any material change in physical condition during the interval.

Comet Tempel.—Tempel's first periodic comet, and of rather unusual interest, was unfortunately missed at its return in 1892, being unfavorably situated for observation.

Comet Tempel$_3$-Swift:
=Comet 1891 V.

This periodic comet returns to the sun once in every five and a half years, but under conditions alternately favorable and unfavorable for observation. It was originally discovered by Tempel in 1869, was picked up again in 1880 by Swift, and again upon this return by Barnard. At its intermediate returns in 1875 and 1885 it was so situated with reference to the earth and sun as to have been entirely invisible. A very carefully prepared ephemeris by Bossert, taking account of the perturbations from 1880, enabled Barnard to find the comet on September 27, 1891, and it was independently found by Denning at Bristol on September 30. It was described as a faint, shapeless nebulosity, with slight condensation about the center, but even at its brightest, towards the end of November, it was a difficult object for precise observation, a fact all the more to be regretted as its position would render it of especial value for the determination of the distance of the sun.

Comet Winnecke: =Comet 1892 IV. Winnecke's well-known periodic comet was picked up at this return, through the help of von Haerdtl's ephemeris, by Spitaler at Vienna on March 18, 1892; it was then an exceedingly faint and small nebulous mass with stellar nucleus of the sixteenth magnitude. It increased in brightness towards perihelion (on June 30), and after perihelion was observed in the southern hemisphere till the end of September.

Comet 1886 IV,* which was discovered by Brooks on May 22, 1886, was expected to make its first return to perihelion in the latter part of 1892, but was not found. The orbit is somewhat uncertain.

Comet 1889 V.—To quote from the first of a series of masterly papers on the orbit published by Mr. Chandler in the Astronomical Journal: "The vicissitudes in the history of this comet give it an interest exceeded, perhaps, by no other in astronomical annals; and the settlement of the problems connected therewith promises to illuminate our knowledge of cometary mechanics in various important particulars.

While the manner in which the comet became separated into several parts, by its encounter with Jupiter in 1886, may possibly require for its precise exposition the observations which will be obtained at the next appearance in 1896, we may hope for an approximate answer in the careful discussion of those made in 1889 alone. . .

To begin with, it is necessary to notice some of the physical phenomena presented by the companions. The notation used will be the letters assigned by Barnard, *B C D* and *E* in order of the distances from the main comet *A*. As is known, *B* and *C* were detected by him on August 1, with the 12-inch, *D* and *E* on August 4, with the 36-inch. It is desirable to remark here that the reason for their not having been discovered in the previous month, on July 8, 9 and 10, can not have been superposition by perspective, at least in the case of *C* and the more distant companions; for the orbit of *C* . . . shows that such superposition occurred two months previous to discovery of *A* by Brooks, and gives for July 8 a distance of 190″ at 62°.5 position angle. That the companions were not seen in July, may be naturally ascribed to interference of moonlight up to about July 20, and after that either to the fact that the attention of observers was not sufficiently directed to the phenomenon, or to the fact that the objects had not yet become bright enough to be easily discernible. We have the evidence of Spitaler that on July 30 and 31 nothing abnormal was noticed with the 27-inch; the slight elongation on those dates, seen by him in *A* having no relation to the matter in hand. Two nights after, at the time of discovery, Barnard estimated the brightness of *C* at about one-fifth that of *A*. It then gradually increased in brilliancy, also becoming less diffused and developing a strong condensation and nucleus, until at the end of August it was actually brighter than *A* although only one-third its size. In early September it was about equal in brightness to *A* but from the middle of that month faded, and became larger and more diffuse until it disappeared, late in November. The faint nucleus of *B*, in the beginning appears to have been a little brighter than that of *C*, and its coma smaller and less diffused. About the middle of August it had grown to be larger and fainter than at first, later more rapidly so, being excessively difficult to see or measure in the first few days of September, and invisible immediately thereafter. *D* and *E* were measured only on the night of discovery, and were seen only at rare intervals until the last time on August 29.

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* See Smithsonian Report 1887, p. 123.

Such, briefly described, are the main features as to brightness and visibility of these objects. I beg courteously to dissent from the view which has been confidently expressed, that the diffusion and disappearance of *B*, while it was theoretically increasing in brightness, indicate 'that it actually dissipated itself into space and absolutely ceased to exist, if indeed it were not absorbed into the main comet.' Such a conclusion is inherently improbable, unwarranted by any knowledge we possess as to the process of cometary light development, and contradicted by inferences drawn from other cases, of which only the most analagous need be cited, namely, that of the two nuclei of Biela's comet, the capricious action of which affords a strict counterpart to the present instance. It will be recollected that fitful alternations of visibility occurred in 1846, and especially in 1852, when they repeated themselves almost from day to day. The two companions were not habitually seen at the same time, but sometimes one, sometimes the other; so that observers could not tell which they were looking at, without comparison with the ephemeris. Thus, in the space of one week, for example, 1852, September 15 to 22, both nuclei were visible, then only the southern, then only the northern, then both together; again only the southern, and, finally, only the northern, on successive nights, respectively.

It may be added that there appears to be little reason for interpreting these remarkable variations of brilliancy as standing in any relation of effect with cause which produced the disruption, either in Biela's comet or in 1889 V; but much more for supposing that similar behavior may be common, in greater or less degree, escaping attention ordinarily from the difficulty of photometric comparisons in the case of isolated comets, but easily attracting the eye, by contrast, when two objects nearly alike are in the same field."

Mr. Chandler's discussion of the orbits of these companions establishes the important proposition that the force which led to the separation of the components A and C, whatever its nature, operated in the plane of the comet's orbit, and produced no change in that plane or in the form of the conic section, but only in its size, and in the direction of its major axis. With reference to the identity with Lexell's comet, Mr. Chandler sees no sufficient reason in the differences of the period of revolution (28.18 years, according to Mr. Poor, instead of 27 years) to reject the supposition; it is necessary to carry the computation of the perturbations a little farther back.

Comet 1890 II.—The last observation in 1891 was on May 29 by Spitaler at Vienna; but it was again favorably situated in January and February, 1892, and was observed at Nice up to February 4, 1892.

Comet 1891 I:
=Comet *a* 1891.

Discovered by Barnard at the Lick Observatory on March 29, 1891, and independently by Denning at Bristol on March 30. It was quite bright, tenth to eleventh magnitude, about 1′ in diameter and with a tail 10′ to 30′ long. At the time of discovery its position was $\alpha = 15^\circ$, $\delta = +45^\circ$; it moved rapidly south, increasing in brilliancy, and was followed after perihelion till July, the last observation having apparently been obtained at Cordoba on July 9, 1891.

Comet 1891 II:
=Comet *b* 1891.
=Comet 1884 III.
=Wolf's comet.

First detected upon this its second appearance by Spitaler, of Vienna, on May 1, 1891, and by Barnard on May 3, its position agreeing closely with the ephemeris. It was at first small and faint, but in August it had a bright nucleus of the eleventh magnitude, with coma of 3′ to 4′ diameter: it decreased in brightness again after the middle of October, but was observed till March 31, 1892. Early in September the comet passed over the group of the Pleiades, and the circumstance was taken advantage of by a number of astronomers to determine whether the light from these stars underwent any refraction in passing through the material of which the comet was composed. The results obtained were for the most part negative, with the possible exception of an observation by Burnham on September 2, when the difference of declination between 21 and 22 Asterope seemed to show some change as the comet passed over them.

The orbit of this comet may bring it at times close to Jupiter, and indeed the perturbations by that planet in 1875 were so great that an altogether new orbit resulted. The period of revolution is about six and three-fourths years.

Comet 1891 III:
=Comet *c* 1891.
=Encke's comet.

See comet Encke.

Comet 1891 IV:
=Comet *e* 1891.

A telescopic comet of the twelfth magnitude, discovered by Barnard at the Lick Observatory on October 2, 1891. At the time of discovery it was in the constellation Argo; it moved farther south and was not seen at all in the northern hemisphere except at the Lick Observatory, where it was followed up to October 9; in the southern hemisphere it does not seem to have been followed beyond October 11.

Comet 1891 V:
=Comet Tempel$_3$-Swift.
=Comet 1869 III.
=Comet 1880 IV.
=Comet *d* 1891.

See comet Temple$_3$-Swift.

Comet 1892 I:
=Comet *a* 1892.

Discovered by Swift on March 6, 1892, at 17^h Rochester mean time, or 5 o'clock on the morning of March 7, in 30° south declination; the brightest comet seen in the northern hemisphere since the great September comet of 1882. At the time of its greatest brilliancy, which was at perihelion, April 6, it was as bright as a star of the third or fourth magnitude, with a bright, round head and nucleus of 10″ to 15″ diameter. The tail, on the other hand, was exceedingly faint, and was variously estimated at from 1° to 20° in length. Barnard reported it on April 3 as double. The photographs of the tail were of unusual interest, especially those taken in March at Sydney and in April at Mount Hamilton. On the morning of April 5 a photograph, made by Barnard at Mount Hamilton with a 6-inch lens, showed three main branches to the tail, each being separated into several others, so that in all at least a dozen could be counted. At a distance of two degrees from the head, along the northern side of the middle tail, there was a sudden bend southward. On the 7th "the southern component, which was the brightest on the 5th, had become diffused and fainter, while the middle tail was very bright and broad; its southern side, which was the best defined, was wavy in numerous places, the tail appearing as if disturbing currents were flowing at right angles to it. At 42′ from the head the tail made an abrupt bend towards the south, as if its current was deflected by some obstacle. In the densest portion of the tail, at the point of deflection, is a couple of dark holes similar to these seen in some of the nebulæ."

The comet was visible to the naked eye till the beginning of June, and was still under observation with the telescope at the close of the year.

The spectrum as observed by Konkoly on April 1 and 2 consisted of a continuous spectrum and five bright lines, while Campbell, at the

Lick Observatory, whose observations extend from April 5 to June 13, saw, in addition to the continuous spectrum, the three usual cometary bands, the less refrangible sides of these bands being sharply defined and the middle one, in fact, terminated by a very bright line.

The orbit of the comet is undoubtedly elliptic, belonging to the interesting group of comets with a period of about two thousand years. During this appearance, as it was for a considerable time in the neighborhood of Jupiter, its path may be considerably changed.

Comet 1892 II:
=Comet *c* 1892.

Discovered by Denning, at Bristol, on March 18, 1892, in 23^h right ascension, and 59° north declination; it was then at its maximum brightness, small, round, with central condensation of from eleventh to twelfth magnitude, and no tail. It remained small and inconspicuous, but was under observation for several months. The orbit is parabolic, without specially interesting peculiarity.

Comet 1892 III:
=Comet *f* 1892.
=Holmes's comet.

Discovered by Mr. E. Holmes, at London, on November 6, 1892, near the great Andromeda nebula, and also independently on November 9, by Davidson, at Mackay, Queensland—a round nebulous mass 5′ in diameter with a central condensation, but no tail; the suspicion that it was a return of Biela's comet was shown to be unfounded as soon as sufficient observations were available for a determination of its orbit, though the orbit proved to be elliptic and of short period. A short faint tail was seen soon after discovery, and upon a photograph taken by Barnard, on November 10, it can be followed for half a degree, while about a degree from the head and beyond the tail there is a diffused nebulous object, apparently belonging to the comet, and this connection seems substantiated by Campbell's spectroscopic observations.

The comet was visible to the naked eye to the end of November and in telescopes of medium power during the first part of December, and then diminished very rapidly in brightness, not following at all the computed scale of brilliancy, but showing a remarkable and inexplicable outburst about the 16th of January, 1893. The spectrum was also peculiar in that it seemed to be purely continuous.

According to the elements computed by Schulhof the comet passed perihelion on June 13, 1892, and its period is 6.9 years; the orbit seems to lie entirely within that of Jupiter, the nearest possible approach of the two being 0.4, (the mean distance of the earth from the sun being 1,) but since 1861 the two bodies do not seem to have been very close at any time. The small eccentricity, not far from that of Tempel's first periodic comet, brings it quite near to the upper limits of the eccentricity of the asteroid orbits. But with such a short period, as it can not have experienced great perturbations since 1861, the reason for its never having been seen at a previous return, is a mystery which seems to be connected in some way with the very great and abnormal variation in brightness actually detected while under observations, the cause of which still lies beyond us in the unknown characteristics of cometary material.

Comet 1892 IV:
=Comet *b* 1892.
=Winnecke's comet.

Found by Spitaler, at Vienna, on March 18, 1892.

See Comet Winnecke.

Comet 1892 V:
=Comet *e* 1892.

Especial interest attaches to this comet, as it is the first discovered by photography, if we except the single case of the "Tewfik comet," shown near the sun on a plate exposed during the total eclipse of May 17, 1882. The present comet was detected as a suspicious looking object upon a plate exposed near *α* Aquila on October 12, 1892, by Barnard. On the following evening the cometary character of the object was confirmed by the 12-inch refractor. It was faint, 1′ in diameter, and from twelfth to thirteenth magnitude, somewhat condensed toward the center. It changed but little in appearance and was last seen in December.

Dr. Krueger's elements give a period of revolution of only 6.3 years and show a remarkable resemblance to those of Wolf's comet—so great, in fact, as to suggest a common origin for the two, as in the case of Biela's comet and Brooks's comet, 1889 V.

Comet 1892 VI:
=Comet *d* 1892.

Discovered on August 28, 1892, in the constellation Gemini, by Brooks, a quite bright, round nebula, with distinct nucleus and short faint tail; it was visible to the naked eye in November, and the tail could be followed, upon a photographic plate, November 26th, for 5°; after the middle of December the comet was observable only in the southern hemisphere.

The spectroscope showed a continuous spectrum with the three usual cometary bands.

Comet 1893 I:
=Comet *g* 1892.

This comet was also discovered by Brooks, at Geneva, N. Y., in the constellation Bootes, on the morning of November 19, 1892; it was then quite bright for a telescopic comet, but showed no tail, while its increase in brightness and northerly motion made it an easy object for observation during the rest of the year.

In chronicling the comets of the year 1892 mention should be made of a suspicious object detected by Prof. M. Wolf upon photographic plates exposed on March 19 and 20, 1892. It could not be found upon a photograph of March 22 nor in a later search with the great Vienna refractor.

The announcement of a comet discovered by Freeman on November 26, 1892, proved to be erroneous.

A comet announced by Swift on December 23, 1889, has been identified by Dreyer with a nebula discovered by Herschel, and is, therefore, to be stricken from the list of lost comets.

Approximate elements of the comets of 1891 and 1892.

Designation.		Perihelion T (Greenwich mean time).	☊		ω		i		q	e
			°	′	°	′	°	′		
1891	I	1891, Apr. 27.56	193	56	178	48	120	31	0.397	....
	II	1891, Sept. 3.46	206	22	172	48	25	15	1.592	0.557
	III	1891, Oct. 17.98	334	41	183	57	12	55	0.340	0.847
	IV	1891, Nov. 12.94	217	39	268	33	77	43	0.977	....
	V	1891, Nov. 17.34	296	31	106	43	5	23	1.087	0.653
1892	I	1892, Apr. 6.69	240	54	24	31	38	42	1.027	0.999
	II	1892, May 11.22	253	26	129	19	89	42	1.971	....
	III	1892, June 13.27	331	42	14	11	20	47	2.140	0.410
	IV	1892, June 30.89	104	5	172	6	14	32	0.886	0.726
	V	1892, Dec. 11.05	206	39	170	14	31	12	1.429	0.581
	VI	1892, Dec. 28.09	264	28	252	41	24	48	0.976	....
1893	I	1893, Jan. 6.52	185	39	85	14	143	52	1.195	....

Designation.		Discoverer.	Date of discovery.	Synonym.	Remarks.
			1891		
1891	I	Barnard	Mar. 29	1891 *a*	
	II	Spitaler	May 1	1891 *b*	Wolf's comet. Period 6.8 years.
	III	Barnard	Aug. 1	1891 *c*	Encke's comet. Period 3⅓ years.
	IV	Barnard	Oct. 2	1891 *e*	
	V	Barnard	Sept. 27	1891 *d*	Tempel$_2$-Swift. Period 5.5 years.
			1892		
1892	I	Swift	Mar. 7	1892 *a*	
	II	Denning	Mar. 18	1892 *c*	
	III	Holmes	Nov. 6	1892 *f*	Period 6.9 years.
	IV	Spitaler	Mar. 18	1892 *b*	Winnecke's comet. Period 5¾ years.
	V	Barnard	Oct. 12	1892 *e*	Period 6.3 years.
	VI	Brooks	Aug. 28	1892 *d*	
1893.					
	I	Brooks	Nov. 19	1892 *g*	

METEORS.

A fine shower of meteors, radiating from the neighborhood of γ Andromedæ, was seen in the United States and Canada on the night of the 23d of November, 1892. There seems to be no doubt that it was a part of the great stream connected with Biela's comet, which was encountered on the 28th of November, 1872 and 1885. On these two occasions the earth probably passed through the main swarm, while in 1892 it passed some days earlier through an associated branch of it. From a comparison of the positions of the comet and of the dates of the meteoric showers in 1798, 1838, and 1872 Prof. Newton was long ago led to conclude "that a long, extended group of meteor particles must accompany the comet in its periodical revolution, preceding it to a distance of 300,000,000 miles in front, and following it to a length of 200,000,000 miles in the rear of its actual position, or occupying, if there is no reason to suppose the elongated meteor current discontinuous, fully 500,000,000 miles in its observed length along the comet's path."

SOLAR SYSTEM.

Motion of the solar system.—Prof. Porter has discussed the proper motions of 1,340 stars contained in publication 12 of the Cincinnati observatory. Adopting Dr. Schönfeld's method of dividing the stars into four groups, according to the magnitude of their proper motions, he has confirmed Dr. Stumpe's result that the proper motion of a star is an index of its distance from us. The mean position of the "sun's way" from his figures is 281°.2 right ascension and +40°.7 declination.

Dr. Vogel has also published the results of an inquiry on this subject based on the measured velocities of stars in the line of sight. The motion of fifty-one stars has been determined at Potsdam, and the probable error in the measurement is below 1.16 geographical miles, but the resulting value of the apex of motion, though the observations have been discussed in various ways, is not in very satisfactory accord with other investigations. If the stellar motions be treated either with equal weights, or weights approximately proportional to those assigned by Dr. Vogel in his catalogue of proper motions, the coordinates of the apex are 206°.1 ± 12°.0 in right ascension, and + 45°.9 ± 9°.2 in declination, with a velocity of 11.60 ± 1.85 geographical miles.

SUN.

Diameter of the sun.—A large number of heliometer measures of the diameters of the sun and Venus made by the German transit of Venus parties in 1874 and 1882, incidental to the more important determination of the solar parallax, have been discussed by Dr. Auwers, who finds for the mean result of the sun's diameter (thirty-one observers) 1,919″.3, which differs considerably from that adopted in the various ephemerides; the Berlin Jahrbuch, for instance, uses 1,922″.4, the Connaissance des Temps and British Nautical Almanac1, 923″.6, and the American Ephemeris 1,924″.0. Dr. Auwers remarks that if the value he finds is affected by irradiation it can only be too large, while the adopted diameters are larger still. He announces that a change will be made in the value used by the Berlin Jahrbuch in the volume for 1895.

Temperature of the sun.—The numerous attempts that have been made to determine the temperature of the sun have led to the most discordant results, the figures varying from 1,500° to 5,000,000°. The method employed, however, has always been the same (that of Pouillet), and the experimental determinations have been sufficiently concordant in themselves, the divergencies arising from the different laws adopted to connect the radiation of incandescent bodies with their temperature. Newton's law, which holds only for an interval of a few degrees, gives for the temperature of the sun millions of degrees. Dulong's, which is only exact over a range of 150° at most, gives 1,500°. Rosetti's law, established by experiments made between 0° and 300°, gives 10,000°. A more recent series of experiments has been made by M. H. Le Chatelier, and is published in the *Comptes Rendus* for March 28, 1892, in which the temperatures employed cover a range of 1,100° (700° to 1,800°). The "effective" temperature that he finds for the sun is 7,600°, which he thinks may be subject to an uncertainty, on account of errors which may effect the law of radiation, not greater than 1,000°, the "effective" temperature being that temperature which a body of emissive power equal to unity must have in order to send us radiations of the same intensity as the sun. The actual temperature of the photosphere is higher, for a part of its radiations are absorbed by the less highly heated solar atmosphere, and perhaps also (although this seems hardly probable) because the emissive power of the sun may be less than unity.

Solar activity in 1892.—The development of the solar activity during 1892 was no less marked with regard to prominences than with regard to sun spots. On April 6 Trouvelot reported an arched prominence extending some 90,000 miles along the limb of the sun and attaining a height of over 57,500 miles. Two days later an enormous protuberance rose to a height of 71,970 miles, extending in a little over half an hour to 105,550, and a week later another extending over 255,000 miles along the circumference.

The great sun spot group of 1892.—It appears that the original formation of the group took place on the farther side of the sun, and it first came under observation on November 15, 1891, when it was seen as a spot of considerable size close to the east limb. On November 16 the group consisted of three spots, and by November 18 it had assumed the appearance so typical of the more important disturbances, of a long procession of spots of various sizes, the spot in the van and that in the rear being the largest. During the December appearance (December 12–24) it was throughout one well-defined circular spot.

One spot, roughly circular in shape, alone appeared on January 7. It is not quite clear whether it represented the principal group of the November appearance or the little group which formed in advance of it and which became prominent during December. It seemed to occupy a position nearly midway between the two, though the two are practically to be regarded as one disturbance.

Before its appearance at the east limb on March 4 a great change had taken place. The group, which on February 13 had covered more than 3,000 millionths of the sun's visible hemisphere, did not cover one-fifteenth of that area on March 5, though it revived somewhat before it was last seen at the west limb on March 17, but did not survive to make a sixth appearance at the east limb on March 31 or April 1.

According to Mr. Maunder the great spot, the largest on record at Greenwich, was 92,000 miles long and 62,000 miles broad, while the entire group of which it formed the principal part was 162,000 miles long and 75,000 broad. The area of the spot on February 13, 1892, was 2,940 million square miles, and the whole group 3,530 million square miles. This is about eighteen times the area of the earth, and seventy globes as large as ours could have lain side by side in the immense hollow. Mr. Maunder thinks that the effect upon the weather of a spot even of such enormous size must be very slight, if appreciable. The magnetic needle, however, undergoes violent disturbance upon their appearance.

In an article in Knowledge for April and May, 1892, Mr. Maunder brings forward some important evidence in regard to the connection between sun spots and magnetic storms. The article concludes as follows:

> In a period of nearly nineteen years, therefore, we have three magnetic storms which stand out preëminently above all others during that interval. In that same period we have three great sun spot displays—counting the two groups of April, 1882, together—which stand out with equal distinctness far above all other similar displays. And we find that the three magnetic storms were simultaneous with the greatest development of the spots. Is there any escape from the conclusion that the two have a real and binding connection? It may be direct, it may be indirect and secondary only, but it must be real and effective.
>
> Consider that the period in question is practically some six thousand eight hundred days. A magnetic storm does not last many hours: a sun spot soon declines from its greatest development, or soon passes away from the center of the apparent disk. Suppose we take an outside limit, and give a period of two days to a giant spot to exercise its influence or a magnetic storm to expend its violence; what are the probabilities against 3 out of 3,400 of such periods of the one phenomenon agreeing with 3 out of 3,400 of the other, if they are not related? If 3,400 numbers were placed in one box and 3,400 more in a second, and one from each box were drawn at a time, what is the chance that the three highest numbers would be drawn from the one box simultaneously with the three highest from the other, each to each, if the matter had not been prearranged? Indeed, we might legitimately call the coincidence of April, 1882, a double one, and ask the odds against the four highest numbers from each box being so drawn.
>
> Between sun spots and storms of the second magnitude it is more difficult to make a satisfactory comparison, because it is not so easy to frame a satisfactory definition as to what constitutes a secondary disturbance. Nevertheless, the following brief table of large sun spots seen since the beginning of 1881, which were coincident with considerable disturbances, may prove of interest. The spotted area is given in millions of square miles:

Date.	Spotted area.	
	Entire sun.	Largest group.
1881—January 31	1,295	686
September 12	2,089	917
1882—October 2	2,480	1,234
October 5	2,065	1,198
1883—April 3	1,545	607
April 19	2,170	670
June 30	3,650	2,210
July 11	1,887	1,009
July 29	1,425	1,264
September 17*	2,017	1,263
October 16	4,730	1,733
October 20	1,650	1,369
1883—November 1	2,100	784
November 19	3,682	1,600
1884—March 2	1,510	609
April 24	2,348	1,510
April 30	1,746	897
1885—January 23	1,687	592
February 5	1,345	571
February 13	1,569	480
May 26*	1,923	647
June 24*	2,348	1,681
July 18	1,835	504
1891—November 22*	1,966	1,371

Some of the above, those marked with an asterisk, may fairly be taken as confirming, though with less definiteness, the conclusion drawn from the correspondences between the greatest spots and the greatest storms. But with the others it is not so. Spots as important have been seen upon the sun, and the magnets have scarcely fluttered, and storms as distinct have occurred when there have been only few spots, and those but small, upon the visible disk of the sun. The table is important, therefore, not as adding to the weight of the evidence in favor of the connection between sun spots and magnetic disturbances, but as emphasizing a point which must not be forgotten. Though the diurnal and annual changes of terrestrial magnetism conclusively prove the solar influence upon it, though the conclusion between the general sun-spot cycle and the general magnetic cyle is clearly established, though even in minor irregularities the two curves closely correspond, and though unusually large sun spots are answered by unusually violent magnetic storms, we can not, as yet, proceed further and express the magnitude or character of the magnetic disturbances in terms of the spotted area of the sun or of its principal groups at the time of observation. The conclusion to my own mind seems to be that though sun spots are the particular solar phenomenon most easily observed, we must not infer, therefore, that their number and extent afford the truest indication of the changes in the solar activity which produce the perturbations we remark in our magnetic needles.

Solar prominences.—Especial attention has been given to the photography of solar prominences by Prof. G. E. Hale of the Kenwood observatory, Chicago, and by M. Deslandres of the Paris observatory. Prof. Hale suggested two plans for the purpose; the first was to allow the image of the sun to drift across the radial slit of a powerful spectroscope, the driving clock of the telescope being slowed to produce the drift. If then there were a prominence on the sun's limb the length of any bright line at the focus of the spectroscope would define the height of the prominence, and as the sun drifted across the slit this line would continually change in length. If now the line in use were made to pass through a slit just within the focus of the observing telescope of the spectroscope called the "second slit," so as to be in focus on a plate beyond the slit, all that is required to photograph the prominence is to move the plate slowly at right angle to the second slit. Fresh portions of the plate are thus exposed to corresponding portions of the prominence, and the prominence image is built up from a succession of bright line images of the slit. In the second method proposed, the clock of the equatorial is so adjusted that the image of the sun is kept in a fixed position. The plate on the end of the collimator which carries the slit, is then slowly moved across the sun's limb at the point where the prominence is present, and a second slit moving at the same speed before a stationary plate excludes the light from the spectrum on either side of the line in use, and reduces fogging to a minimum.

In April, 1891, Mr. Hale secured the first photograph of the spectrum of a prominence obtained without an eclipse. This showed two very strong, bright lines nearly at the centers of the dark solar bands H and K. The same lines were photographed on subseqent occasions, but it was not until June 23, that any new lines were discovered. On this occasion four lines were obtained in the ultra-violet—a number since increased to six. Of these six, 5 lines belong, unmistakably, to the series of hydrogen lines discovered by Dr. Huggins, in the ultra-violet of the spectra of Sirian stars. The sixth line forms a close double with one of these hydrogen lines (α) but its origin has not yet been accounted for.

Mr. Hale's conclusion that H and K are not due to hydrogen, is abundantly confirmed by Prof. Young and also by M. Deslandres, since the measures have shown beyond a doubt that the "companion line to H," and not H itself, is the one really due to hydrogen. Mr. Hale and M. Deslandres ascribe these two giant bands of the solar spectrum to calcium.

Mr. Hale has also met with considerable success in photographing the forms of solar prominences, some of the photographs showing a satisfactory amount of detail. In one instance a prominence photographed at Kenwood was being sketched by Herr Fényi at Kalocsa at the same moment of time, and drawing and photograph are in close accord. A suggestion by M. Deslandres that it might be possible to photograph the entire chromosphere at a single exposure has been carried into effect by Mr. Hale, by means of a "spectroheliograph," in which the slit of the spectroscope is made to travel across the image of the sun, and a precisely similar motion, but in an opposite direction, is given to a second slit nearly in the focus of the view telescope, and so arranged that the K line of the spectrum of the fourth order falls upon it. Since the K line is always bright in the spectrum of the chromosphere and prominences, it is easy, by shutting off the image of the sun by means of a diaphragm, to build up a complete picture of the entire chromosphere and prominences, and so to produce what may be described as an "artificial total solar eclipse." The discovery which Mr. Hale has made that the H and K lines are always reversed in the faculæ has enabled him to extend the application of this principle. If the diaphragm covering the image of the sun be discarded a photograph will be obtained, not merely of the chromosphere and prominences, but of the disc of the sun itself, showing the spots and the faculæ, the latter being depicted, not merely when near the limb of the sun, but wherever they occur, even in the very center of the disc. In this manner it has been discovered that faculæ, invisible to the eye frequently float above the spots, and one series of photographs in particular, show how, on July 15, a luminous outburst formed, spread, completely hid a large group of spots, and passed away, all in a few minutes of time.

The *double* reversal of the H and K lines from faculae, a phenomenon shown upon photographs taken at Kenwood, Paris, and Stonyhurst, is a discovery of special interest as bearing upon the interpretation of the enigmatical spectrum of *Nova Aurigæ*, and Prof. Hale has supplemented this discovery by obtaining a similar result with an integrating spectroscope, the sun being treated as a star would be, its light as a whole, and not only from special regions of the disc, being subjected to examination.

M. Deslandres has been making further experiments upon photographing the corona without an eclipse. The principle upon which he proceeds is to obtain photographs of the sun from light of limited refrangibility, not by using colored media or stained plates, but by means of two prisms, the second of which is arranged so as to recompose the light dispersed by the first. But only certain rays from the first prism are allowed to fall on the second; the resulting image of the sun is, therefore, confined to those rays which can be selected at pleasure. M. Deslandres' purpose is, therefore, to find out for what rays the corona has the greatest brightness as compared with that of the sun, and to photograph the sun and its surroundings by their aid alone. (*See* Month. Not., 52:292; 53:277.)

ECLIPSES.

Eclipse of the moon, 1888, January 28.—In number 23 of the Publications of the Astronomical Society of the Pacific is an unusually satisfactory drawing by Prof. Weinek, showing the delicate shades of color exhibited by the eclipsed moon.

Eclipse of the sun, 1889, January 1.—Prof. Pritchett's report of the Washington University party, which was stationed at Norman, Cal., is illustrated by an excellent artotype, a composite reproduced by hand from four negatives. The evidence given by these photographs upon the structure of the corona is thus summarized "The marked structural features of the corona are (*a*) the so-called filaments, and (*b*) the streamers extending approximately in the direction of the ecliptic. The filaments extend over a region of 20 degrees or more on each side of the poles. They are straight lines of light arranged somewhat like the spines of a fan, and are not radial. The dark spaces between them are not entirely free of coronal matter, but can be traced in some cases to within a short distance of the sun's limb. The broad and strongly marked equatorial belt stretches directly across this mass of filaments, apparently cutting off the filaments at the somewhat irregular line of separation. The impression conveyed to the eye is that the equatorial stream of denser coronal matter extends across and through the filaments, simply obscuring them by its greater brightness. There is nothing in the photographs to prove that the filaments do not exist all round the sun.

Eclipses of 1891 and 1892.—In the year 1891 there were two eclipses of the sun, an annular eclipse on June 6, and a partial eclipse on November 30–December 1; and two eclipses of the moon, May 23 and November 15, both total.

In 1892 there were also four eclipses, two of the sun and two of the moon: a total eclipse of the sun April 26, and a partial eclipse of the sun October 20; a partial eclipse of the moon May 11 and a total eclipse November 4.

Eclipse of the moon, 1891, May 23.—A total eclipse, visible throughout the western part of the Pacific Ocean, Australia, Asia, Africa, and Europe. No observations of special importance.

Eclipse of the sun, 1891, June 6.—Visible as an annular eclipse only in the northern part of Siberia and the Arctic Ocean. A few observations of contacts were secured in the western part of the United States.

Eclipse of the moon, 1891, November 15.—The total eclipse of the moon on November 15, 1891, was visible generally throughout North and South America, Europe, Asia, and Africa. The whole of the eclipse was visible in the eastern and central parts of the United States while in the western part the moon rose eclipsed. Dr. Döllen selected from photographic plates made at Potsdam some 138 stars to be occulted at established observatories, but the weather seems to have been generally unfavorable. A few contact observations were secured.

Eclipse of the sun, 1891, November 30.—A partial eclipse, visible only in the Antarctic ocean.

Eclipse of the sun, 1892, April 26.—Total eclipse, visible only in the Southern Pacific; no observations of importance reported.

Eclipse of the moon, 1892, May 11.—The phenomenon of the partial eclipse of the moon on May 11, 1892, was studied at Greenwich and elsewhere, and the occultation of a considerable number of small stars was observed.

Eclipse of the sun, 1892, October 20.—Partial eclipse, visible in North America; a few observations of contacts reported.

Eclipse of the moon, 1892, November 4.—Total eclipse visible generally in Europe and America. No observations of special importance.

SOLAR PARALLAX AND THE TRANSITS OF VENUS.

The United States transit of Venus observations.—In a report dated September 21, 1891, the Superintendent of the United States Naval Observatory states that no provision has yet been made for publishing in detail the work of the American parties upon the transit of Venus in 1882—a fact greatly to be regretted. The publication of the work upon the 1874 transit is only partly completed and considerable work still remains to be done upon the reductions for 1882, though results for the solar parallax and certain elements of the orbit of Venus, which are practically final, have been published. Some occultations of stars by the moon, telegrapic determinations of differences of longitude, tidal observations, and pendulum experiments still remain to be reduced, for which, however, no funds seem to be available.

Dr. Auwers' result* for the German heliometer measures of the transit of Venus in 1874 is a solar parallax of 8″.877 ± 0″.043, there being in all 308 measures at four different stations; in 1882 four stations were occupied and 446 measures were obtained, the resulting parallax being 8″.879 ± 0″.037.

Dr. Battermann, of the Berlin Observatory, has deduced a value of the solar parallax from 250 occultations of stars between April, 1884, and October, 1885, having by careful observation been able to utilize the occultations of a considerable number of faint stars near new moon. The resulting solar parallax is 8″.794 ± 0″.016.

The determination of the solar parallax by means of meridian observations of Mars at opposition was attempted in 1862, and again in in 1877, but the results obtained were generally considered by astronomers as too large, there being indications of a systematic error in the observations of Mars, or of the comparison stars, or of both. A slight modification of the previous methods of observation was suggested by Prof. Eastman, and a circular was issued by the U. S. Naval Observatory requesting the coöperation of other observatories in the observation of Mars during the opposition in the summer of 1892.

PLANETS.

MERCURY: *Diameter of Mercury.*—A new determination of the diameter of Mercury has been made by Mr. Ambronn from heliometer observations at Göttingen, the mean result being 6″.580, comparing favorably with the generally adopted value.

Transit of Mercury, May 9, 1891.—A transit of Mercury over the sun's disk took place on May 9, 1891, the first since November 7, 1881. The observation of these transits no longer possesses special importance, as the determination of the solar parallax, for which they are theoretically valuable, can now be made more accurately by other means. Observations of the contacts between the disks of the sun and planet are useful in determinations of the planet's orbit and the physical phenomena are sometimes of interest. The transit on May 9, 1891, was only partially visible in the United States. On the Pacific coast the sun was two or three hours high at the time of the first and second contacts; it had set in most places on the Atlantic coast before the first contact, and in Washington was only ten minutes high. Reports from twenty-five observers in the United States have been forwarded to the Naval Observatory for reduction. The whole transit was visible in China, Japan, eastern Siberia, and the Malaysian Islands, while in England egress took place soon after sunrise. No phenomena of special importance seem to have been noted. In Europe several observers saw the "black drop" or ligament. At the Lick Observatory a careful series of observations was made, both visual and photographic, and the planet was looked for, but without success, before it entered upon the sun's disk.

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* Astron. Nachr. 3066.

For more than an hour after ingress the planet was also carefully examined, with the 36-inch Lick telescope, by Profs. Holden and Keeler. It "was perfectly round, and in the best moments sharply terminated . . . . Not the slightest trace of a satellite was seen; and both observers were confident that no such body could then be on the sun's face and escape detection unless it were exceedingly minute."

VENUS.—The conclusion reached by Schiaparelli that Venus rotates very slowly upon its axis, in fact in about the same time that it rotates about the sun, has been challenged by several observers. MM. Niesten and Stuyvaert, of the Brussels Observatory, have given the matter careful study, and M. Trouvelot has published a series of observations and sketches from 1876 to 1891, from which he concludes that the rotation does not differ greatly from twenty-four hours.

An exhaustive discussion of recent publications concerning the physical appearance of Venus is printed by Dr. Wislicenus in the *Vierteljahrsschrift*, v. 27, pp. 271–302. It is quite evident that further accurate observations are necessary.

The value of the diameter of Venus, deduced by Dr. Auwers from the heliometer measures by the German Transit of Venus parties, in 1874 and 1882, is 16″.80.

THE EARTH: *Variation of terrestrial latitude.*—One of the most important subjects that has been under discussion during the past two years—important to astronomy and geodesy alike—is the variation of terrestrial latitudes, the strong suspicion of which has been confirmed by recent very accurate observations, and when once admitted is abundantly fortified by the discussion of older observations.

There seems to be now distinct evidence of a rotation of the geographical round the astronomical pole in 427 days. The problem has of course attracted the attention of the ablest astronomers and mathematicians, but the credit for the ablest discussion and the most satisfactory solution is undoubtedly due to Mr. S. C. Chandler. The following summary of his work is taken from a review in the *Monthly Notices* (v. 53, No. 4).

Mr. Chandler's observations with the almucantar, in 1884 and 1885, first suggested to him, not only the possibility of a variation in latitude, but the law of the variation. Twelve months' observations were of course not sufficient to establish a periodicity of fourteen months, though they might suggest it; confirmation was, however, furnished by Dr. Küstner, who, in his determination of the aberration from a series of observations coincident in time with those of the almucantar, came upon similar anomalies. Further evidence bearing on the question was forthcoming in the parallel determinations at Berlin, Prague, Potsdam, and Pulkowa, which showed changes in apparent latitude, not only strikingly sympathetic among themselves, but of the same range and periodicity as those noticed in 1885; and Mr. Chandler "was led to make further investigations on the subject, which seem to establish the nature of the law of these changes, and proceeded (1891, November) to present them in due order."

The consequent series of papers in the *Astronomical Journal* can hardly fail to take its place as one of the astronomical classics. The following summary is made purposely very brief because the series is not yet complete, and no doubt much still remains to be said on such an important subject. But it will be seen that during the year 1892 (including perhaps the end of 1891) a most important advance has been made in fundamental astronomy.

The first paper (regarding that already mentioned as preliminary) deals with the observations with the Pulkowa vertical circle (1865-1875), "which have been provocative of so much inquiry, so far without any solution of the anomalies which they show in regard to the question of latitude variation," and the Washington prime vertical observations (1862-1867), "the most accurate determinations of declination ever made at the Naval Observatory," which yet "resulted in anomalous values of the aberration constant in the different years and a negative parallax in all." Mr. Chandler finds that a 427-day period in the latitude "furnishes the true key to the troublesome discordances in the Pulkowa latitudes," and "traces to their origin the anomalies in the Washington observations." Further, the comparison of the two series leads to the same conclusion as that already shown from the simultaneous series at Berlin and Cambridge (United States) in 1885 as to the direction of the polar motion. In the next paper it is mentioned that observations at Melbourne (1863-1884) and Leyden (1863-1867) are in complete accordance with those made at the same time at Pulkowa and Washington; and that the 427-day period accounts for the contradictory results obtained by Dr. Van Hennekeler at Leyden. The motion of the earth's pole for the period 1860-1870 is thus fairly established. The author proceeds to consider earlier observations. In the papers numbered 3 and 4, the systematic errors of Bradley's observations, which were reduced afresh for this purpose, are discussed, particularly the collimation error. It is then concluded that the observations indicate a rotation of the pole in little more than a year and with a larger radius than that of 1860–1880, the range being about 1″. In the same paper Mr. Chandler states that Brinkley's observations at Dublin (1808–1813 and 1818–1822) are found to indicate a rotation in about a year, with range more than 1″, "wherein lies the solution of the hitherto unsolved enigma of Brinkley's singular results which led to the spirited and almost acrimonious dispute between Brinkley and Pond with regard to stellar parallaxes." The details were promised in a later paper, but have not yet been given, owing doubtless to the necessity of attending to a vitally important point which will presently appear.

In papers 5 and 6 are presented the results of an enormous mass of reductions extending from 1837 to 1891, made at no fewer than seventeen observatories. The whole is broken up into forty-five series, or short groups, for the purposes of this particular discussion; and the result of this minute inquiry, confirmed (or perhaps suggested) by the observations of Bradley and Brinkley above mentioned, seemed clear, viz, that the "instantaneous rate of angular motion of the pole has been diminishing during the last half century at a sensibly uniform rate, by its one-hundred-thousandth part."

Mr. Chandler was led to modify this statement in a remarkable manner and within a few weeks.

Astronomers had hesitated to accept the 427-day period, even in face of the very strong evidence of the 1860–1880 observations, owing to the difficulty in accounting for it theoretically. It had been pointed out by Euler that, treating the earth as a rigid body, the period of rotation of the pole must be 306 days. Prof. Newcomb, however, happily pointed out that a qualified rigidity (either actual viscosity or the composite character due to the ocean) afforded an explanation of this longer period; and after this suggestion Mr. Chandler's 427-day period was well and even warmly received. But the further elaboration of this hypothesis by a changing period was a new difficulty.

Prof. Newcomb, who had reconciled the first article of the hypothesis with theory, was not slow to declare that the second was irreconcilable. Mr. Chandler's reply, in paper 6, is a model of controversial courtesy and skill. He says: "It should first be said that in beginning these investigations I deliberately put aside all teachings of theory, because it seemed to me high time that the facts should be examined by a purely inductive process; that the nugatory results of all attempts to detect the existence of the Eulerian period probably arose from a defect of the theory itself; and that the entangled condition of the whole subject required that it should be examined afresh by processes unfettered by any preconceived notions whatever. . . . The appeal to observation, treated irrespective of theory in the present series of papers, shows that a rotation of the pole really exists, but (*a*) at a daily rate of but 0°.85 (for 1875), and (*b*) that this velocity is subject to a slow retardation, which in its turn is not uniform . . . The result (*a*) was at first pronounced impossible, and it is even now so regarded in some quarters. Prof. Newcomb, however, soon after found the defect in the theory, and is now as cordially in favor of the result given by observation as he was originally against it.. . . . Now, may it not reasonably be asked, if the direct deduction from observation has led to the correction of the theory in the first particular, is it beyond hope that it may do so in regard to the second?"

Such a truly scientific attitude inspires confidence that the search is being rightly conducted; but the most sanguine could hardly be prepared for the reconciliation of observation and theory in the very next paper of the series, published six weeks later.

By this time Mr. Chandler had rearranged his material, and found, not *one variable* rotation of the pole, but *two constant* rotations (with a qualification), one in 427 days and the other in about a year. The qualification is that the *amplitude* of the latter is apparently variable, not the period. The superposition of these two rotations is almost exactly equivalent, for the observations available, to the law (or summary of observation, as it might fairly be called) previously announced. To make clear the novelty of this discovery it may be remarked that, although fluctuations in zenith distances of annual period have long been recognized, they have generally been ascribed to temperature effects, in which case the maxima and minima for all stations in the Northern Hemisphere should occur at the same epoch—say, midsummer and midwinter. But this is not the case with the annual term now revealed. The epoch changes with the longitude, showing that the pole moves just as in the case of the 427-day term.

It is somewhat remarkable that two formulæ differing so much in form should be found to represent the observations almost equally well. Apparently this is to be attributed chiefly to the variability in amplitude of the annual term, and as yet this variability has not been accounted for. But to have advanced the work to this stage in such a short time is a great achievement, and much may confidently be expected from Mr. Chandler's future work. He points out, in a paper dated January 2, 1893, that the discovery of these periodic inequalities in the latitude makes it necessary to go over much old work afresh, and is himself leading the way with a discussion of the aberration constant.

In the same paper he shows that the recent results obtained at Berlin, Prague, Strasburg, Pulkowa, Rockville, and Honolulu give a mean correction to his final formula of only five days in the epoch; "and the accordance of the separate values is high testimony to the skill of the observers, to whom astronomers owe a deep debt of gratitude for their laborious and conscientious work."

Standard time.—In reviewing the recent progress made in the introduction of uniform standards of time M. Pasquier states that in Canada Parliament has declared as legal the normal hours from Greenwich adopted since 1883 by railways and later by a great number of towns. In England a commission has reported favorably upon the system of hourly meridians, and the Government has strongly recommended it to the colonies. In France, Paris mean time is used for all the country, including Algeria. In Belgium a commission has recommended the hourly meridian system, with Greenwich as the starting point. In Holland the Government has authorized the adoption of Greenwich time for interior railway service. In Prussia mean European time (mitteleuropäische Zeit or M. E. Z.) which is one hour greater than Greenwich time, replaced Berlin time from the 1st of June, 1891, for the railway service of the interior. Bavaria, Würtemberg, and Baden have also decided on M. E. Z., which will also be used in Alsace-Lorraine. Austria and Hungary adopted M. E. Z. from October 1, 1891, for railway, post, and telegraph service, and there is a strong feeling for its adoption in civil life. In Italy, at the instance of the Academy of Sciences of Bologna, which favors the meridian of Jerusalem, there was a plan for assembling a new congress at Rome, but this however, seems to have been abandoned. There is here as well as in Switzerland a strong sentiment in favor of Greenwich as the standard.

At the Cape of Good Hope the extension of railways brought about the adoption of a single-standard time throughout the colony in February, 1892. The meridian one and one-half hours east of Greenwich is in use for all purposes in Cape Colony and the Orange Free State, and all time signals are given at Greenwich noon.

Sky glows.—The after-glows that attracted so much attention in 1883 and 1884 showed some signs of return, though in lesser degree, in the early part of 1891. The tint and general appearance are reported to have greatly resembled the auroral displays.

The systematic study of these "luminous night clouds" has been taken up by Prof. Foerster and Herr Jesse, of the Berlin observatory.

The Moon.—A valuable contribution has been made to the study of the moon in "An essay on the distribution of the moon's heat and its variation with the phase," by Mr. F. W. Very, of the Allegheny Observatory—a paper which gained the prize proposed in July, 1890, by the Utrecht Society of Arts and Sciences. Mr. Very's investigation was made with one of Langley's "bolometers," and the principal results may best be described in the author's own words:

> First, that visible rays form a much larger proportion of the total radiation at the full than at the partial phases, the maximum for light being much more pronounced than that for the heat. Next, as has been foreseen from the eccentricity of the heat areas, their greater extension toward the western limb, and the greater steepness of the sunset than of the sunrise gradient, the diminution of the heat from the full to the third quarter is slower than its increase from the first quarter to the full. Finally, there is a fair agreement between these results and those of Lord Rosse, which extends even to some minor details, such as the attainment of the highest heat at little before the full.

In a discussion of the moon's atmosphere Mr. Ranyard expresses the opinion that the moon can not have an atmosphere one two-thousandth part as dense as that of the earth at sea level. It must, however, be remembered that, were our atmosphere transferred to the moon, its density would only be one-sixth what it is on the earth.

Professor Weinek, of Prague, who has been making a special study of the Lick photographs of the moon, has detected several new rills and craters on the negatives.

MARS.—Mars was in opposition to the sun on August 3, 1892, and though the planet was also at this time very favorably situated as regards its proximity to the earth, its great southern declination was a serious impediment to observation in the northern hemisphere. At the Harvard observatory station, Arequipa, Peru, the planet was, however, almost in the zenith, and full advantage was taken of this by Prof. W. H. Pickering and his assistants. Many of Schiaparelli's canals were identified; some were seen double, and marked changes were detected in progress in various parts of the planet, especially in the neighborhood of the *Lacus solis* or Terby sea. Prof. Pickering and other observers detected a number of bright white spots besides the polar snow cap.

In an article in the March number of *L'Astronomié*, 1891, Flammarion describes various changes in the topography of Mars, the most striking of which are also in connection with the Terby sea. Drawings are given of its appearance in 1877, 1879, 1881, and 1890; briefly, it seems to have undergone cleavage, and while some former "affluent canals" have disappeared, other new ones have developed. The strait called Herschel II has been transformed into a straight double canal.

JUPITER: *Discovery of a fifth satellite.*—The most interesting astronomical event of the year 1892 was the discovery by Barnard, with the 36-inch Lick equatorial, on September 9, of a fifth satellite of the planet Jupiter.

Following is Prof. Barnard's own account of his discovery, in describing his search for new objects in the Astronomical Journal:

> Nothing of special importance was encountered until the night of September 9, when, in carefully examining the immediate region of the planet Jupiter, I detected an exceedingly small star close to the planet and near the third satellite. I at once measured the distance and position angle with reference to satellite III. I then tried to get measures referred to Jupiter, but found that one of the wires had got broken, and the other loosened. Before anything further could be done the object disappeared in the glare about Jupiter. Though I was positive the object was a new satellite, I had only the one set of measures, which was hardly proof enough for announcement.
>
> I replaced the wires the next morning. The next night with the great telescope, being Prof. Schaeberle's, he very kindly gave the instrument up to me, and I had the pleasure of verifying the discovery, and secured a good set of measures at elongation.
>
> Just what the magnitude of the satellite is it is at present quite impossible to tell. Taking into consideration its position, however, in the

glare of Jupiter, it would perhaps not be fainter than the thirteenth magnitude.

The satellite has been seen and its position observed at the University of Virginia, at Princeton, at Ealing, and at Evanston; the 18½ inch refractor at Evanston being apparently the smallest instrument with which it has thus far been seen, and it was then reported as being a much more difficult object than Ariel or Umbriel, the satellites of Uranus, though Mr. Reed with the 23-inch Princeton glass found it an easier object than Ariel.

The new satellite's orbit seems to lie sensibly in the plane of Jupiter's equator; the distance of the satellite from the center of the planet is probably over 110,000 miles and its period of rotation about $11^h\ 57^m\ 37^s$.

Diameter of Jupiter.—An admirable series of measures of the diameter of Jupiter, by Dr. Schur, with the Göttingen heliometer, is published in No. 3073 of the *Astronomische Nachrichten.* The effect of personal equation was eliminated by the use of a reversion prism eyepiece. Dr. Schur finds the disk a sensibly true ellipse with diameters 37″.4 and 35″.0, a flattening of 1–15½.

Mr. Burnham communicated to the November meeting of the Royal Astronomical Society, in 1891, a paper on the spots and markings of Jupiter as observed with the 12-inch equatorial of the Lick Observatory. Noting the decided changes of color in the different markings on the planet's surface, he expresses the opinion that the red color is an indication of age, or, in other words, when a spot or marking other than the white spots first appears it is dark or black, but after some time turns red. During the year 1891 the planet was extremely interesting, owing to the remarkable amount and variety of detail displayed on its surface. The two hemispheres were, as usual, strongly in contrast in their individual markings. In the southern hemisphere, besides the great red spot, new spots appeared, and a great number of round white spots were visible. These white spots are quite characteristic of the southern hemisphere, though individual white spots have at rare intervals been seen in the northern hemisphere. In the latter a system of small dark spots appeared, with very short periods of rotation. Mr. Burnham reports that the great red spot had regained much of its former distinctness, both in color and form.

SATURN.—On September 22, 1891, the earth passed through the plane of Saturn's rings. From the 22d of the month to October 30 the earth was above the plane of the rings, while the sun was below that plane and, consequently, shining on the southern side of the rings. After October 30 the sun was again shining on the north side. The phenomenon of the disappearance of the rings was described by several observers.

URANUS.—A search for new satellites made by several observers at the Lick Observatory from 1889 to 1891 has resulted negatively. The observers were satisfied "that no new satellite half as bright as Ariel at elongation exists within the orbit of Umbriel. It is not likely that any such object exists within the orbit of Titania."

NEPTUNE.—Mr. Asaph Hall, jr., finds that observations of the satellite with the 26-inch Washington refractor from October, 1891, to March, 1892, confirm the reality of the slow motion, nearly proportional to the time, of the orbit plane of the satellite with respect to the orbit of Neptune, to which Mr. Marth called attention and which M. Tisserand shows may result from a slight flattening of the planet.

MINOR PLANETS.

Asteroids of 1891.—Of the asteroids announced in the last report, No. 286 has been named Iclea, 296 Phaëtusa, 297 Caecilia, 298 Baptistina, 299 Thora, 300 Geraldina, 301 Bavaria. An asteroid, discovered on November 14, 1890, by Charlois, at Nice, and subsequently found to be a new one, has been named Clarissa. To No. 323, photographed by Dr. Wolf November 28 (the first asteroid discovered by photography), he has given the name Brucia, in honor of Miss Catherine W. Bruce, who has contributed so generously for the advancement of astronomy.

In 1891 twenty-two new asteroids were added to the group revolving between Mars and Jupiter, and photography now having become a powerful aid in the detection of these small bodies, the number still likely to be found seems almost limitless. The last on the list for 1891, No. 323, was discovered by Dr. Wolf upon his photographic plates. Another asteroid was, in fact, found upon the same plate, but it proved to be identical with 275 (Sapientia).

Palisa, on August 14, 1891, discovered what was for a time supposed to be a new planet, but it was found to be identical with 149, Medusa, discovered in 1875; 275, which had not been seen since the opposition of its discovery (1888), has been found again by the aid of photography; 318 is interesting from the almost exact commensurability of its period with that of Jupiter.

No. 302, Clarissa (discovered November 14, 1890), was not included in the last list published, and is, therefore, introduced here to make the lists complete.

List of minor planets of 1891.

Number.	Name.	Discoverer.	Date of discovery.
			1890.
302	Clarissa	Charlois at Nice	Nov. 14.
			1891.
303	Josephina	Millosevich, at Rome	Feb. 12
304	Olga	Palisa, at Vienna	Feb. 14
305	Gordonia	Charlois, at Nice	Feb. 16
306	Unitas	Millosevich, at Rome	Mar. 1
307	Nike	Charlois, at Nice	Mar 5
308	Polyxo	Borelly, at Marseilles	Mar. 31
309	Fraternitas	Palisa, at Vienna	Apr. 6

List of minor planets of 1891—Continued.

Number.	Name.	Discoverer.	Date of discovery.
			1890.
310	Margarita	Charlois, at Nice	May 16
311	Claudia	do	June 11
312	Pierretta	do	Aug. 28
313	Chaldaea	Palisa, at Vienna	Aug. 30
314		Charlois, at Nice	Sept. 1
315	Constantia	Palisa, at Vienna	Sept. 4
316		Charlois, at Nice	Sept. 8
317	Roxane	do	Sept. 11
318		do	Sept. 24
319		do	Oct. 8
320	Katharina	Palisa, at Vienna	Oct. 11
321		do	Oct. 15
322	Phaeo	Borelly, at Marseilles	Nov. 27
323	Brucia	Wolf, at Heidelberg	Nov. 28

Asteroids of 1892.—The further and very successful application of photography to the discovery of asteroids by Dr. Wolf, at Heidelberg, and by M. Charlois, at Nice, resulted in such rapid additions to the list that the notation of these bodies was thrown into the utmost confusion. Hitherto the simple numbering in the order of discovery had been a rule easily applied by the discoverer, but where several asteroids were found upon a single photographic plate it was not always possible to determine until later observations and computations whether they were really new asteroids or not, and when the planetary character of the object was recognized it was frequently found imprinted upon some earlier photograph.

It was accordingly suggested, in No. 266 of the *Astronomical Journal*, that as a temporary omission of the number is attended with less inconvenience than is caused by the employment of an erroneous one, the numbers for the asteroids after number 322 should be omitted until the difficult task of fixing a definite enumeration should be delegated by common consent to some one authority to which all could defer.

Common consent seemed to point to the Berlin Rechen-Institut as the only place actually in possession of the needful resources for solving the questions of identity continually arising, and it was agreed that to avoid further confusion Prof. Krueger, director of the Kiel observatory, the European "Central-Stelle," and editor of the *Astronomische Nachrichten*, should assign to each asteroid a provisional notation (1892 A, 1892 B, 1892 C, etc.) in the order of its announcement to the "Telegraphische Central-Stelle;" and that the definitive numeration should be subsequently undertaken by Prof. Tietjen, director of the Rechen-Institut, in Berlin. In this definitive assignment of numbers those asteroids will be omitted, for which sufficient material is not available for a determination of the orbits.

The first asteroid to which the new notation was assigned was that discovered by Wolf, at Heidelberg, on August 22, 1892; it was provisionally known as 1892 A, and subsequently received its more permanent designation, number 333, from Prof. Tietjen, and its name, Badenia, from the discover.

In 1892 thirty new asteroids were announced; one of these, 1892 B, has already proved to be identical with Erigone, 163; and it is possible that further study will identify some of the others.

Some slight discrepancies are still found in the different lists of asteroids for the year, but as the new system of notation becomes established they will probably disappear.

In the following list all the discoveries were by photography except 324, 326, 327, and 331. In the case of the photographic discoveries the date given is that of the earliest photograph on which the planet appears. It was in many cases not noticed on the plate till considerably later, which accounts for the departures from chronological order in the "date of discovery":

List of minor planets of 1892.

Letter.	Number.	Name.	Discoverer.	Date of discovery.
	324		Palisa, at Vienna	Feb. 25
	325	Heidelberga	Wolf, at Heidelberg	Mar. 4
	326	Tamara	Palisa, at Vienna	Mar. 19
	327	Columbia	Charlois, at Nice	Mar. 22
	328	Gudrun	Wolf, at Heidelberg	Mar. 18
	329	Svea	do	Mar. 21
	330	Ilmatar	do	Mar. 19
	331		Charlois, at Nice	Apr. 1
	332	Siri	Wolf, at Heidelberg	Mar. 19
1892 A	333	Badenia	do	Aug. 22
1892 B	163	Erigone	do	Sept. 1
1892 C	335	Roberta	Staus, at Heidelberg	Sept. 1
1892 D	336		Charlois, at Nice	Sept. 19
1892 E	337		do	Sept. 22
1892 F	338		do	Sept. 25
1892 G	339	Dorothea	Wolf, at Heidelberg	Sept. 25
1892 H	340		do	Sept. 25
1892 J	341		do	Sept. 25
1892 K	342		do	Oct. 17
1892 L	334		do	Aug. 23
1892 M	344		Charlois, at Nice	Nov. 15
1892 N	343		Wolf, at Heidelberg	Nov. 15
1892 O			Charlois, at Nice	Nov 23
1892 P			do	Nov. 25
1892 Q			do	Nov. 28
1892 R			do	Nov. 28
1892 S			do	Dec. 8
1892 T			do	Dec. 9
1892 U			do	Dec. 14
1892 V			Wolf, at Heidelberg	Dec. 16

OBSERVATORIES.

The chief sources of information concerning the recent work of astronomical observatories are the *Vierteljahrsschrift der Astronomischen Gesellschaft*, for continental and a few American observatories, and the *Monthly Notices* for English observatories; in addition to these are the reports of the observatories themselves—though few publish independent annual reports—and notes in current journals, chiefly the *Observatory* and the *Sidereal Messenger*.

In the following résumé the length of the notes is by no means always in proportion to the importance of the institution. The character of the work of the older observatories is generally too well known to require more than the briefest mention, while for the new observatories an effort is made to put on record as much information with regard to the equipment, etc., as can be found. In most instances it has not seemed necessary to distinguish between the two years covered by the review.

Among papers of interest on observatories is a series of notes on visits to some American observatories made by Mr. H. F. Newall, of the Cambridge Observatory, England, and published in the *Observatory*.

ABASTUMAN.—A new mountain observatory has been established at Abastuman ($2^h\ 51^m\ 25^s$ E, $+\ 41°\ 42'.4$). It is 4,500 feet above sea level and is equipped with a 9-inch telescope by Repsold.

ADELAIDE: *Todd*.—Reobservation of Weisse stars; observations of Jupiter; weather service.

ALABAMA UNIVERSITY.—An astronomical observatory attached to the University of Alabama, near Tuscaloosa, was completed in the summer of 1844. The building was originally 54 feet in length by 22 in breadth in the center. In 1858 another apartment, 40 feet in length by 20 in width, was added to the east wing. The instruments consist of a 4-inch transit circle of 5-feet focus by Simms, the circle being 3 feet in diameter, divided to five minutes, and read by four microscopes to single seconds; a clock by Molyneaux; an equatorial, also by Simms, of 8 inches aperture and 12 feet focus, provided with a filar micrometer and double image micrometer, the hour circle being divided to one second of time and the declination circle to five seconds of arc, read by opposite verniers. As an accessory to the equatorial there is an excellent clock by Dent. There are also two portable achromatic telescopes—one by Dolland of 7 feet focal length and 4 inches aperture, the other by Simms of 5 feet focal length and 3 inches aperture—and reflecting circle by Troughton, of 10 inches aperture, read by three verniers to twenty seconds.

The observatory was built and the instruments purchased and mounted under the supervision of Prof. F. A. P. Barnard. A woodcut of the building is given in number 15 of the publications of the Astronomical Society of the Pacific, taken from the report of the United States Commissioner of Education for 1889.

ALLEGHENY: *Keeler.*—At a meeting of the board of trustees of the Western University of Pennsylvania on May 11, 1891, J. E. Keeler, of the Lick Observatory, was elected professor of astrophysics in the university and director of the Allegheny Observatory, Mr. F. W. Very being associated with him as adjunct professor of astronomy.

Through the generosity of Mrs. William Thaw the observatory has been provided with a very powerful spectroscope by Brashear; a new driving clock was presented by Mr. William Thaw, jr.

ARMAGH: *Dreyer.*—Micrometric measures of nebulæ; physical observations of Jupiter.

ATHENS: *Eginitis.*—The National Astronomical and Meteorological Observatory at Athens has been reorganized under the directorship of Prof. Eginitis.

BAMBERG: *Hartwig.*—The large heliometer of 184 millimeters aperture has been brought into regular use. Observations of variable stars and of a few occultations have been made, besides observations for the determination of change of latitude.

BASEL: *Riggenbach.*—Instruction of students.

BERLIN: *Foerster.*—Transit circle observations, measures of double stars, etc.

BERMERSIDE (Halifax): *Crossley.*—Measurement of double stars; observation of the phenomena of Jupiter's and Saturn's satellites. Meteorological observations.

BIDSTON: *See* Liverpool.

BIRR CASTLE: *Earl of Rosse.*—Observations for lunar heat. Meteorology.

BONN: *Küstner.*—Prof. Deichmüller was succeeded as director on October 1, 1891, by Dr. Küstner. Observation of the zone +40° to +50° was completed.

BOSTON UNIVERSITY.—A small observatory has been erected for purposes of instruction. Lat. $+42° 21' 32''.5$; long. $4^h 44^m 15^s$ west of Greenwich. The chief instrument is an equatorial of 7 inches aperture and 8 feet 1 inch focus, objective by Clacey and mounting by Saegmuller.

BRESLAU: *Galle.*—Time service and meteorological observations. The one hundredth anniversary of the observatory was celebrated in 1891.

BRUSSELS: *Folie.*—Cloudy weather, an insufficient personnel, and the disturbance incident to the removal of the observatory to Uccle greatly interfered with the work of 1890. M. Niesten has continued his observations on the physical aspect of Mercury, Venus, Mars, and Jupiter, with the 38-centimeter (15 inches) equatorial. Since the death of M. Fievez the spectroscope has been in charge of M. Spée.

BUDAPEST: *Konkoly.*—The new observatory of the Royal Meteorological Reichsanstalt consists of a transit room 6½ meters (21 feet) by

4 meters (13 feet) and a room for the refractor with a dome 4½ meters (15 feet) in diameter. The instrumental equipment is very meager, consisting chiefly of a 4½-inch telescope, a transit, clock, chronometer, chronograph, electrical and other subsidiary apparatus. The director reports but little astronomical work accomplished.

CAMBRIDGE (England): *Ball.*—Prof. Adams has been succeeded as director by Sir Robert Ball. Considerable progress has been made upon the zone work. The 25-inch Newall refractor has been used for physical observations of planets and photography of stellar spectra. A spectroscope has been provided from "the Bruce fund."

CAPE OF GOOD HOPE: *Gill.*—Transit circle observations of the sun, Mercury, Venus, and of stars for a new ten-year catalogue, stars occulted by the moon, stars employed for latitude determinations, etc.; with the heliometer, measures for stellar parallax and measures of Jupiter's satellites have been made, and with the zenith telescope, after its renovation, observations for an investigation of the constant of aberration. The photographic work has consisted of miscellaneous photographs of stars and planets, in addition to regular astrophotographic charting.

The catalogue of the Southern Photographic *Durchmusterung* has been made ready for the press.

CARLETON: *See* Goodsell.

CHAMBERLIN: *Howe*—The building has been completed at a cost of $25,000.

CHICAGO—*See* Kenwood, Yerkes.

COLUMBIA (Missouri): *Updegraff*—The observatory of the University of Missouri (lat. $+ 38° 56' 50''$; long. $1^h 1^m 6^s.4$ west of Washington) was first built in 1853, and then consisted of a small wooden structure in which were mounted a 4-inch Fitz equatorial, a $2\frac{1}{16}$-inch transit by Brunner, a sidereal clock, and other smaller instruments. It was used for the purpose of instructing students in astronomy, and few changes or additions were made till 1880, when a 7½-inch equatorial by Merz & Mahler was bought. The building was then removed to another part of the college grounds and enlarged by the erection of a brick tower, with a dome, for the newly acquired telescope. Soon after a sidereal clock, a chronograph, and spectroscope, all by Fauth & Co., were purchased. A 2-inch altazimuth, by Blunt, of New York, had been bought some years before. The director at that time was Prof. Joseph Ficklin, who died in September, 1886.

Prof. Milton Updegraff was appointed director in July, 1890, and while much of his time is taken up in teaching classes in astronomy and mathematics, he has done excellent work in the observation of planets and comets, besides a redetermination of latitude and longitude, the latter by telegraphic connection with the observatory of Washington University, St. Louis. The observatory building has been enlarged by the addition of an office room and a library.

COPENHAGEN: *Nielsen.*—M. Victor Nielsen at his private observatory has a 7½ inch refractor by Reinfelder and Hertel, the objective of Jena glass. The work has been chiefly upon the moon.

CROWBOROUGH HILL: *Roberts.*—Mr. Isaac Roberts' new observatory is one of the highest points in the south of England, 780 feet above sea level. The hemispherical dome has two slits to effect thorough ventilation. Photographs of stars, planets, nebulæ, and clusters. A photographic search has been made for a trans-Neptunian planet.

DAKOTA AGRICULTURAL COLLEGE (Brookings, Dakota.)—Founded in 1891; equipment, 5-inch equatorial, 2-inch transit, clock and chronograph.

DENVER.—*See* Chamberlin.

DRESDEN: *Dr. B. von Engelhardt.*—Observations of comets, nebulæ and asteroids, and micrometric measures of Bradley stars.

DUDLEY: *Boss.*—Miss Catherine Wolfe Bruce, of New York city, who is already known for her munificent gifts in aid of astronomy, has given $25,000 to the Dudley Observatory for the increase of its permanent endowment. From various sources the additional sum of $31,700 has been secured to defray the cost of rebuilding the observatory on a new site and of furnishing it with a new equatorial of 12 inches aperture, together with other improvements in its equipment. The cost of the telescope is provided for by Robert C. and Charles L. Pruyn; it is to be of the most approved modern construction. The cost of re-establishing the Olcott meridian circle (8 inches aperture), constructed by Pistor and Martins, of Berlin, in 1858, together with a collimating meridian mark and other improvements, is also provided for. The old site is very unfavorable to astronomical observation, owing to its proximity to the four tracks of the New York Central Railroad, which with a very heavy traffic, group around the base of Observatory Hill at a distance of about 150 yards from the instruments. The new site is about 2 miles southwest of the present location upon a plot of about 6 acres.

DUNSINK: *Rambaut.*—On February 20, 1892, Sir Robert Ball was appointed to succeed Prof. Adams at Cambridge, and the vacancy in the directorship of the Dunsink Observatory was filled October 22 by the appointment of Dr. A. A. Rambaut. Dr. Rambaut's assistant is Mr. A. E. Lyster. The 15-inch reflector has been used for stellar photography, principally for determinations of stellar parallax.

DÜSSELDORF: *Luther.*—Observations of asteroids and computation of ephemerides. The passage of railroad trains at a distance of 320 meters from the observatory has not seriously interfered with the observations.

EALING: *Common.*—An excellent 5-foot mirror and a new grating spectroscope have been made for the great telescope. Photographs of nebulæ and of the moon have been taken.

EDINBURGH: *Copeland.*—The reduction of the meridian observations of nebulæ has been undertaken and some further observations have been made at Dunecht, but little observing has been done pending the completion of the new buildings. The main building of the new observatory is to be 180 feet from east to west, terminating in two towers surmounted by domes, or rather "drums." The eastern tower, rising to a height of 75 feet, will contain the 15-inch Grubb refractor, while the 24-inch reflector from the old site at Calton Hill will be mounted in the western dome. A single range of rooms, opening on a corridor on the south, extends from tower to tower. The roof is designed as an asphalted platform, affording free communication between the towers. Beginning at the west there are a spectroscope room, general laboratory, electrical room, cleaning room, mechanic's workshop, chronograph and class room. Light and dark photographic rooms, as well as a computing room for the equatorial and photographic work, are in the eastern tower. A central extension of the building toward the south, 80 feet by 26 feet, will contain the chief computing room, hallway, etc., director's room, and fire-proof library—34 feet by 23 feet, with a light iron gallery affording access to the upper shelves. An upper story to the southern part of this portion of the building, 66 feet in length, is designed for optical work. In the basement will be placed the heating apparatus, a dynamo, and accumulators for supplying electricity for lighting the observatory and illuminating the instruments. In the observatory there will thus be but one chimney.

The transit circle will be in a separate building, with light walls and roof of corrugated iron, 80 feet west of the western tower, accessible by a covered way. The remaining buildings are the astronomer's house, two assistants' houses, and a gate lodge.

GENEVA: *Gautier.*—Col. Emile Gautier died on February 24, 1891, and was succeeded in the directorship by his son, R. Gautier. The principal work of the observatory is the testing of watches and chronometers, and meteorological observations. A number of observations of comets have also been made.

GLASGOW.—Meridian circle observations.

GÖTTINGEN: *Schur.*—Observations of asteroids, comets, and Præsepe, and measures for stellar parallax; regular meridian observations, and physical observations of the moon, Jupiter, Saturn and Uranus.

GOODSELL: *Payne.*—The observatory of Carleton College received a new name, in honor of Mr. C. F. Goodsell, the founder of Carleton College, on June 11, 1891.

The new Williams equatorial, costing $15,000, was installed in 1891. Its clear aperture is 16.2 inches and focal length 22 feet, the lenses having been figured by Brashear upon Hastings' curves and the mounting provided by Warner and Swasey.

GOTHA: *Harzer.*—Reduction of previous observations. The director's time has been given almost entirely to lectures and to his theoretical investigations.

GREENWICH: *Christie.*—The regular work of the observatory has been continued much the same as in previous years, and in addition astrophotographic observations have grown to be a part of the routine, more especially the catalogue of guide stars for the photographic chart. A 9-inch Grubb photographic telescope has been presented to the observatory by Sir Henry Thompson and has been mounted on the Lassell equatorial as a photoheliograph. The erection of the new 36-foot dome, which is to cover the 28-inch refractor, was begun in December, 1892. A discussion of Greenwich observations from 1851 to the present time by Mr. Thackeray has furnished a very satisfactory confirmation of Mr. Chandler's doubly periodic variation of the latitude (in about 365 and 427 days, respectively). A successful longitude campaign has been carried on with Montreal, and the difference of longitude between Greenwich and Paris has been redetermined by English and French observers. Some additions to the equipment have been made and the details of an electric-light installation have been settled.

HAMBURG: *Rümker.*—Observations of comets, asteroids, and comparison stars; chronometer work for the German navy; meteorological observations, and time service.

HARVARD COLLEGE: *Pickering.*—With the meridian circle the observation of stars in the southern Durchmusterung zone (−9° 50′ to −14° 10′) has advanced toward completion. The 15-inch equatorial has been employed on observations partly photometric and partly micrometric, while the principal work done with the west equatorial has been the study by Argelander's method of the changes in the light of the variable stars of long period.

Photographic observations, provided for by the Henry Draper memorial, have been carried on continuously, generally throughout every clear night, and with the aid of three telescopes.

An attempt to secure a suitable location for the Boyden Fund observing station on Wilson's Peak, in southern California, proved unsuccessful, but an expedition sent out to Peru, under the direction of Prof. W. H. Pickering, left Cambridge in December, 1890, and established a station about 3 miles northwest of Arequipa, where a 13-inch equatorial was mounted and observations were commenced. The station is over 8,000 feet above sea level, and has a nearly cloudless sky during a large part of the year; the thermometer rarely falls below 40° F., and rarely goes above 70°. The brilliancy of the stars is most striking; stars of the 6.5 magnitude are picked out easily with the naked eye, the eleven Pleiades can be counted, and the Gegenschein can be readily seen any evening after 9 o'clock.

The Harvard Observatory time service, which had been in operation with but little interruption since 1856, was discontinued after March 31, 1892, having become financially unprofitable, by reason of the fact that time signals from the United States Naval Observatory were offered to the public in Boston through the Western Union Telegraph Company at a lower rate than they could be furnished by the Harvard Observatory.

HATHORN (Saratoga Springs, N. Y.): *del Corral.*—Physical observations of Jupiter with a 6-inch telescope.

HAVERFORD COLLEGE: *Leavenworth.*—Work on stellar parallax; sun-spot observations.

HEIDELBERG: *Wolf.*—Stellar photography, photometric observations. Prof. Wolf has been very successful in the discovery of new asteroids by photography.

HERÉNY: *von Gothard.*—Spectroscopic researches; photography of nebulæ; observations of variable stars; meteorological observations; time service, and computations of asteroids.

HONGKONG: *Doberck.*—Time service; meteorological and magnetic observations.

IOWA UNIVERSITY: *Weld.*—A student's astronomical observatory has recently been established at the State University of Iowa, Iowa City, under the direction of Prof. L. G. Weld. The main building is 12 feet square, capped by a cylindrical turret in which is mounted a Grubb equatorial of 5 inches aperture, and 77½ inches focal length; a Würdemann transit of 1⅞ inches aperture and 24 inches focus is mounted in a wing 10 by 12 feet. Subsidiary apparatus consists of a 4-inch portable Fitz equatorial, clock, chronometer, and chronograph.

JACKSON (Mich.)—Small private observatory of Mr. U. W. Lawton.

JENA: *Knopf.*—The observatory was founded in 1812 by the Grand Duke of Saxe-Weimar. Observations of comets, occultations, phenomena of Jupiter's satellites, variable star observations; time service; meteorology. A new equatorial of 20 centimeters (7.9 inches) aperture and 3 meters (9.8 feet) has been installed.

KALOCSA: *Fényi.*—Solar and meteorological observations.

KENWOOD: *Hale.*—The Kenwood Physical Observatory, the private observatory of Prof. George E. Hale, had its inception in a spectroscopic laboratory erected in Chicago in the summer of 1888. The addition of a tower and wing during the winter of 1890-'91 brought the building to its present form, and it now includes a reception room, library, equatorial room, "slit room," "grating room," photographic dark room, general laboratory, and workshop. The grating room contains a 4-inch concave grating of 10 feet radius of curvature, mounted in the manner employed by Prof. Rowland. A shorter girder allows the use of a grating of only 5 feet radius in cases when the light source is too faint to admit of the highest dispersion. Sunlight is furnished by a heliostat on a pier some distance to the north of the building. Electrical power is supplied through a gas engine and storage battery and also from the main city wires.

The mounting of the equatorial was finished in March, 1891, by Warner and Swasey, and the excellent 12.2-inch object glass, figured from Dr. Hastings's calculation, by Brashear, was in place and ready for use in April, 1891. The spectroscope is large, the objectives being alike and of 3¼ inches clear aperture and 42½ inches focus, corrected for work in the visual region. The grating is a 4-inch flat, in addition to which there is a 30° white flint prism. A second photographic objective of exactly the same aperture and focal length as the visual glass will be provided and a double tube will replace the single tube, the object glass being so supported that either one may be used on either tube.

The observatory was formally dedicated on June 15, 1891; it has been incorporated under the laws of the State of Illinois and its control is vested in a board of trustees. The plan of work includes a study of solar phenomena, with especial attention to spectroscopic investigations of the spots, chromosphere, and prominences. An interesting and well-illustrated description of the observatory, together with an address delivered at the dedication by Prof. Young, is published in the Sidereal Messenger for August, 1891.

KIEL: *Krueger.*—"Centralstelle für astronomische Telegramme." Spectroscopic and photometric observations, observations of comets and asteroids and computations of orbits and ephemerides.

KÖNIGSBERG: *C. W. F. Peters.*—Meridian observations, heliometer measures of double stars, and for parallax; observations of comets and of the moon. Meteorology.

KREMSMÜNSTER: *Wagner.*—Observations of comets and sun spots. Time service, meteorological and magnetic observations.

LADD: *Upton.*—The Ladd observatory was formally presented to Brown University, Providence, R. I., by Governor Ladd on October 21, 1891. The building and equipment have cost nearly $30,000. The main part of the building is 43 by 27 feet, and the transit room 25 by 15 feet. The chief instrument is an equatorial of 12.2 inches aperture, objective by Brashear, and mounting by Saegmuller. It is one of three recently made by Mr. Brashear from the formulæ of Prof. C. S. Hastings. The mounting embodies several convenient devices. The spectroscope, which is of special excellence, is by Brashear.

The clock room is a chamber in the equatorial pier, and contains a Howard sidereal and a Molyneaux mean time clock. The other instruments are a 3-inch portable transit by Saegmuller; a smaller transit for students' use, a Warner and Swasey chronograph, several chronometers and sextants, a barograph, thermograph, and recording hygrometer by Richard Frères, a recording rain and snow gauge by Ferguson, and ordinary meteorological instruments. The observatory is designed primarily for the instruction of students, but also for research, and the equipment has been planned for a possible extension of the latter as the resources of the observatory may allow. The director is Prof. Winslow Upton.

LEIPZIG: *H. Bruns.*—Parallax measures of stars with large proper motions, observations of planets and asteroids. Zone work +5° to +10°, and +10° to +15°; triangulation of trapezium of Orion. Time service and meteorological observations.

LICK: *Holden.*—A new building has been erected to cover the Willard photographic lens (aperture 5.9 inches, focal length 31 inches), and its mounting by Brashear, presented by Hon. C. F. Crocker. The dome is 10 feet in diameter, and attached to it is a photographic dark room about 10 by 11 feet.

A graduate school of astronomy has been established at the Lick Observatory as a part of the graduate system of the University of California, and a special fund established by Mrs. Phebe Hearst is in part available for the expenses of advanced students elected fellows by the regents.

Barnard's discovery of a fifth satellite of Jupiter with the 36-inch refractor has been referred to elsewhere.

LIÈGE: *Folie.*—This observatory is attached to the Royal Observatory at Brussels, and its observations are published in the Brussels volumes. Much excellent theoretial work has been done by M. de Ball while awaiting repairs to the meridian circle.

LIVERPOOL: *Plummer.*—Time service, chronometers, meteorological observations. The 8-inch equatorial has been used in the systematic observation of comets.

LUND: *Folke Engström.*—Work on zone +35° to +40°.

MCCORMICK: *Stone.*—Prof. Stone has published a continuation of the Bonn Durchmusterung, upon which he has been engaged for a number of years.

MADRAS: *Smith.*—Mr. C. Michie Smith, since the death of Mr. Pogson, has been chiefly engaged in pushing forward the publication of observations of earlier years. Observations other than those required for the efficient maintenance of the time service have been entirely subordinated to the work of publication. Two volumes of the valuable *Madras Meridian Circle Observations* have been issued.

MELBOURNE: *Ellery.*—Meridian circle work has been continued. The photographic telescope was mounted in January, 1891, and considerable progress has been made towards the photographic catalogue. Meteorological and magnetic observations, time service, and chronometer rating have been kept up, but the observatory has been seriously crippled by the reduction of its appropriations, necessitating the retirement of two assistants.

MILAN: *Schiaparelli.*—Measurements of double stars; preparations for a catalogue of 1,100 stars, zone +2° to +6° observed from 1860 to 1872. Longitude work, time service, and magnetic observations.

MISSISSIPPI UNIVERSITY: *Fulton.*—Under date of July 6, 1891, it was reported (Sid. Mess., No. 97) that a "twin equatorial" (a 15-inch visual telescope and a 9-inch photographic telescope side by side on the same mounting) was under construction by Grubb.

MOUNT HOLYOKE (South Hadley, Mass.)—Sun-spot observations.

MOUNT ROSA.—A small observatory is in course of construction on Mount Rosa, 15,000 feet above sea level, consisting of a wooden hut 10 by 30 feet.

MUNICH: *Seeliger.*—A new Repsold 6-inch meridian circle was mounted in July, 1891. Observations of comets and of Saturn with the 10½-inch refractor; investigations of personal equation dependent on the magnitudes of stars; longitude work, meteorological observations.

NATAL.—Observations of the Moon's position and of Mars.

O'GYALLA: *Konkoly.*—Observations of sun spots, drawings of Jupiter; a few spectroscopic observations and some photographic experiments. Much time has been spent in the reorganization of the Government Meteorological Bureau.

OXFORD (University).—The series of observations for determining by photography the parallax of about 30 stars chiefly of the second magnitude has been completed and the results published. Much time has been spent in the preparation of the new instruments to be used on the international chart of the heavens, and a considerable number of plates comprised in the zone assigned to Oxford have been completed. Experimental work has also been done for the committee in charge of the international chart.

A convenient observatory has been erected contiguous to the main building for the exclusive use of university students. This observatory is furnished with two small transit circles, three telescopes, one of which is a reflector of 15 inches aperture, and subsidiary apparatus.

PARIS: *Tisserand.*—In the report for 1891 the director stated that the Gambey circle had been applied to the investigation of the latitude and the question of its variation; observations to determine the constant of aberration were completed, and besides the usual planetary and cometary observations, a considerable number of measurements of double stars and micrometric measures of nebulæ were made.

Photographic work upon the great chart and upon the moon has been continued, and the newly organized department of spectroscopy has obtained interesting results under M. Deslandres.

The report for 1892 contains a tribute to Admiral Mouchez, the late director, an account of gratifying progress in the photographic and spectroscopic work, and with the equatorial coudé. A "Bureau des Mesures des Clichés du Catalogue" has been organized, with Mlle. Klumpke at its head.

POTSDAM: *Vogel.*—The spectroscopic determination of the motion of stars in the line of sight to which Dr. Vogel has given especial attention has been continued, and many of the results have been published. Dr. Scheiner has worked upon stellar spectra and the spectra of solar prominences. Prof. Müller and Dr. Kempf have completed their observations for a photometric Durchmusterung, and Prof. Müller his long series of photometric observations of the planets. Dr. Lohse and Prof.

Spoerer have been engaged in photographic and visual observations of the sun.

PRAGUE: *Safarik.*—Variable stars.

PRAGUE (University): *Weinek.*—Drawings of the moon. Determination of latitude, observations of Jupiter's satellites, time service, magnetic and meteorological observations.

PROVIDENCE (R. I.).—*See* Ladd.

RADCLIFFE (Oxford): *Stone.*—Work on the general catalogue of 6,350 stars for 1890; meridian observations of the sun and moon. Observations of comets, double stars, and occultations. Meteorology.

ROME.—The first fascicule of the publications of the new Vatican observatory contains the interesting Papal Brief founding the observatory, an historical introduction, and two papers on astronomical photography, to which the observatory is to be for the present devoted.

ROUSDON (Lyme Regis): *Peek.*—Variable stars; time service.

SAN DIEGO (Cal.)—Mrs. Proctor, widow of the late R. A. Proctor, proposes to erect an observatory at San Diego as a memorial to her husband; an 18-inch object glass has been ordered.

SAN FERNANDO: *Viniegra.*—Capt. J. Viniegra has been appointed director, to succeed Capt. Pujazon.

SMITH (Beloit, Wis.): *Bacon.*—Sun-spot observations, etc.

STONYHURST: *Sidgreaves.*—Photography of the solar spectrum and of stellar spectra; drawings of sun spots and measures of the chromosphere and prominences. A new 15-inch refractor has been purchased with the fund raised to the memory of the late Father Perry.

STRASBURG: *Becker.*—The meridian circle has been used in observing the zone —2° to —6°, and also the sun, moon, and planets. Some defects in the construction of the altazimuth were remedied and the instrument was used in a careful series of observations for the determination of the variation of latitude, beginning in May, 1891, and ending in March, 1892.

SYDNEY.—Transit-circle work, observations of double stars and of comets; photographic work for the international chart, photographs of comets and of Mars. Weather-chart service.

TEMPLE (Rugby): Double stars; nebulæ photography.

TOULOUSE: *Bigourdan.*—From an account of the history of the observatory by M. Bigourdan it appears that it was originally established in 1729 on one of the towers of the rampart of the town. Garipuy made some observations there, but afterwards erected an observatory on his own house and superseded it by a larger and more commodious one in 1770. Darquier assisted him for a time, but afterwards erected an observatory of his own. Vidal had commenced his astronomical work at the observatory of Garipuy, which, however, became the property of the states of Languedoc after the death of the founder in 1782. Vidal retired in 1807, and, after several attempts to improve the observatory, it was decided in 1840 to erect a new one at the extremity of the town. The buildings were commenced the following year, but it was not until the end of 1846 that they received their instrumental equipment. Garipuy's observatory was then abandoned.

UNDERWOOD (Appleton, Wis.): *L. W. Underwood.*—The Underwood observatory in connection with Lawrence University at Appleton, Wis., was equipped at the opening of the college year of 1892–'93. The outfit consists of a 10-inch Clark equatorial, 4-inch meridian circle, mean-time and sidereal clocks, chronometer, and chronograph. A local time service has been established.

UNITED STATES NAVAL OBSERVATORY: *McNair.*—At the time of the last report of the Superintendent, September 29, 1892, the new buildings were not ready for occupancy. The usual routine observations have been somewhat interrupted by preparations made for the removal of the instruments to the new site, advantage being taken of the interruption of observations to advance the reductions of previous years.

Prof. Asaph Hall was retired by law from active service as a staff officer of the Navy on October 15, 1891.

UPPER TULSE HILL: *Huggins.*—Visual and photographic observations of Nova Aurigæ (1892).

UPSALA: *Dunér.*—Variable stars; stellar photography. A new photographic refractor of 33 centimeters (13 inches) objective has been under construction, and has necessitated some alterations in the building. Time service.

VASSAR: *Miss Whitney.*—Sun-spot observations, observations of comets, etc.

WESTMEATH: *Wilson.*—The 2-foot Grubb reflector has been remounted and used for stellar photography. Some photographs of Jupiter have been taken with a photographic photometer, to determine the relative albedo of the planet and his moons.

WINDSOR: *Tebbutt.*—Observations of comets, double stars, occultations, and the phenomena of Jupiter's satellites.

WOLSINGHAM: *Espin.*—Spectroscopic zone work; double stars. A number of new variable stars have been discovered. Meteorological observations.

YALE.—Dr. Elkin's heliometer work constitutes the chief astronomical activity. In 1891 the series of observations to determine the parallaxes of the first magnitude stars of the northern hemisphere was completed. Observations have also been made of comparison stars for Victoria, and the computations on the Iris series in 1888 have been carried forward chiefly by Miss Palmer. Observations of comets and asteroids were made by Mr. Chase with the 8-inch Reed equatorial.

From July, 1891, to January, 1892, the heliometer was devoted to a series of measures on the satellites of Jupiter for the determination of their orbits, and the mass of the planet. After the completion of this work Dr. Chase completed a triangulation of the principal stars in Coma Berenices. A series of measures of Algol has been made to test the theory of a sensible orbital motion of the bright component, and the theoretical parallax, suggested by Mr. Chandler.

YERKES (University of Chicago): *Hale.*—Through the munificence of Mr. Charles J. Yerkes, of Chicago, the University of Chicago is to have an astronomical observatory of the first class. No definite limit has been assigned to the expenditure contemplated, but it is intimated that the equipment shall be equal to any in existence. The principal instrument will be a 40-inch refractor, the disks for which were made some years since for the University of Southern California.

The remainder of the equipment is still undetermined, but it will probably include a 16-inch refractor, 12-inch "twin" equatorial with visual and photographic objectives, 6-inch meridian circle, and 20-inch siderostat.

ZÜRICH: *R. Wolf.*—Sun-spot observations; observations for determining the variation of latitude; time service.

ASTRONOMICAL INSTRUMENTS.

Brashear–Hastings objectives.—Three large object glasses recently made by Brashear are of more than ordinary interest, as they have been ground by Prof. Hastings' formula. They are the 16-inch of the Goodsell Observatory, the 12.2 of the Ladd Observatory, and the 12-inch of the Kenwood Physical Observatory. The crown glass was obtained from Mantois, of Paris, and the flint from the optical works at Jena, Germany.

A new instrument has been devised by A. Beck, called a "Nadir-Instrument," for the determination of time and latitude by observation of the transits of stars over a circle whose pole is the zenith. The instrument is adjusted for a circle of 60° zenith distance.

To amateurs a series of articles on the "Adjustment of a small Equatorial," in the Journal of the British Astronomical Association (February, 1892), by Mr. Maunder, will undoubtedly prove of interest and value.

MISCELLANEOUS.

Prizes.—The Lalande prize of the Paris Academy for 1891 was awarded to M. G. Bigourdan for the work he has undertaken and partly carried out, of micrometrically measuring all the known nebulæ, about six thousand in number, observable at Paris; this will be a first step to obtaining some knowledge of their proper motions, and ultimately, perhaps, of their distances from the sun. No memoir was presented to the Academy on the special subject proposed for the Damoiseau prize, "To perfect the theory of the inequalities of long periods caused by the planets in the motion of the moon." It was, therefore, proposed again for 1892, and its value fixed at 4,000 francs. Prizes were, however, adjudged, for their planetary and cometary investigations, to MM. Gaillot, Callandreau, and Schulhof. The Janssen prize was awarded to M. Rayet, for his spectroscopic work. This prize is awarded annually for the first seven years after its foundation (1887), and becomes biennial in 1894.

The Lalande prize of the French Academy of Sciences was awarded on December 19, 1892, to Mr. E. E. Barnard for his astronomical discoveries, especially the discovery of the fifth satellite of Jupiter, and to Prof. Max Wolf for his work in astronomical photography, especially in the discovery of asteroids. The Damoiseau prize to MM. Radau and Leveau; the Valz prize to M. Puiseaux for his work on the theory of astronomical instruments and the constant of aberration; the Janssen prize to M. Tacchini for his work on the solar spectrum.

The Donohoe Comet Medals of the Astronomical Society of the Pacific.—The following amended rules for the bestowal of the medal took effect on February 26, 1891.

I. A medal of bronze is established as a perpetual foundation to be given for the discovery of comets, as follows:

The medal is to bear on the obverse side the effigy of a bright comet among stars, with the legend "ASTRONOMICAL SOCIETY OF THE PACIFIC" around the border, and on the reverse the inscription, "THIS MEDAL, FOUNDED IN 1890 BY JOSEPH A. DONOHOE, IS PRESENTED TO ——— (the name of the discoverer) TO COMMEMORATE THE DISCOVERY OF A COMET ON ——— (the date)."

It is to be understood that this medal is intended solely as a recognition of merit, and not as a reward.

II. The medal will be given to the actual discoverer of any unexpected comet.

III. The discoverer is to make his discovery known in the usual way, and, in order to simplify the work of the committee, which, in certain cases may be called upon to consider the merits of several independent discoveries of the same object, he should also address a letter to the Director of the Lick Observatory, which should state the exact time of the discovery, the position of the comet, the direction of its motion (when this can be determined), and the physical appearance of the object.

No application for the bestowal of the medal is required. The letters received from discoverers of comets will be preserved in the records of the Lick Observatory. Cable telegrams to the Lick Observatory are to be addressed to "Astronomer, San Francisco."

IV. All communications will be referred to a committee consisting of the Director of the Lick Observatory, *ex officio*, and of two other persons, members of the Astronomical Society of the Pacific, who are to be annually appointed by the Board of Directors. The decisions of this committee are to be final upon all points relating to the award of the medal. The committee will print an annual statement of its operations in the publications of the society.

Under ordinary circumstances the comet medal will be awarded within two months after the date of the discovery. In cases of doubt a longer period may elapse. The medal will not be awarded (unless under the most exceptional circumstances) for the discovery of a comet until enough observations are secured (by the discoverer or by others) to permit the calculation and verification of its orbit.

V. This medal is to be a perpetual foundation from and after January 1, 1890.

The fourth award of the Donohoe medal was made to Dr. R. Spitaler, assistant in the Imperial Observatory of Vienna, for his discovery of a comet "in the morning hours" of November 16, 1890. This was the first comet discovered by Dr. Spitaler.

The fifth award was made to Prof. T. Zona, adjunct astronomer in the Royal Observatory of Palermo, for his discovery of a comet at $9^h\ 31^m$, Greenwich mean time, November 15, 1890. Also, his first discovery of a comet.

The sixth award was made to Mr. E. E. Barnard, astronomer of the Lick Observatory, for his discovery of a comet at 16 hours, Greenwich mean time, on March 29, 1891. This was the fifteenth comet discovered by Mr. Barnard.

The seventh award was also made to Mr. Barnard for a comet discovered at $0^h\ 55^m$, Greenwich mean time, on October 3, 1891.

The eigth award was made to Dr. Lewis Swift for his discovery of an unexpected comet on March 6, 1892.

The ninth award was made to Mr. W. F. Denning, of Bristol, England, for his comet of March 18, 1892.

The tenth award to Mr. W. R. Brooks, of the Smith Observatory, Geneva, New York, for a comet on August 28, 1892.

The eleventh award was made to Mr. E. E. Barnard for his discovery by photography of an unexpected comet on October 12, 1892, at Mount Hamilton.

The twelfth award was made to Mr. Edwin Holmes, of London, England, for his comet of November 6, 1892.

The thirteenth award to Mr. W. R. Brooks for his comet on November 19, 1892.

The Acton prize.—Once in seven years the Acton prize of £100 is awarded to the person whose scientific writings have been most serviceable to the cause of natural religion. The last prize was adjudged to Prof. G. Stokes, of Cambridge University. The recipient in 1892 was Miss Agnes Clerke, author of the "History of Astronomy in the Nineteenth Century;" of the "System of the Stars;" and of "Studies in Homer."

The Bruce fund.—The fund of $6,000 placed by Miss Bruce in Prof. Pickering's hands to be used in aid of astronomical work, has been applied as follows: To Prof. Newcomb, for a discussion of the contact observations of Venus during the transits of 1874 and 1882; Dr. Plassmann, printing observations of meteors and of variable stars; Astronomische Gesellschaft, construction of tables for the computation of the absolute perturbations of the asteroids by Gyldéns method; International Geodetic Commission, dispatch of a party to the Sandwich Islands for a study of the variations of latitude; Mr. H. H. Turner, computation of tables for reductions of star places; Prof. E. S. Holden, reduction of meridian observations of Struve stars; Prof. H. A. Rowland, identification of metals in the solar spectrum; Dr. L. Struve, reduction of the occultations observed during the eclipse of January 28, 1888.

It may not be out of place here to note that a legacy of 100,000 francs ($20,000) has been left by an old lady of Pau to the Institute of France, as a reward for the person of any nationality who shall, within the next ten years, succeed in communicating with the inhabitants of some other celestial body. Apropos of this legacy, Flammarion has written an interesting article in L'Astronomie as to the possibility of our ever being able to accomplish communication with our neighbors.

The Danish Academy of Sciences and Letters has awarded a gold medal to Baron E. von Haerdtl, of Innspruck, for his memoir on a case of the problem of three bodies proposed by the Acadamy in 1889.

Astronomy and astro-physics.—With its one hundred and first number, the *Sidereal Messenger*, which has been edited by Prof. W. W. Payne, at Northfield, Minn., since 1882, takes a new name, and is enlarged, so that a considerable portion of each number is devoted, under the able editorship of Prof. G. E. Hale, of Chicago University, to what is now known as astro-physics. Prof. Payne continues as senior editor in "General Astronomy," assisted by Prof. H. C. Wilson. The bibliographer will note that, though the journal has a new name, the volume and current number are continued from the *Sidereal Messenger;* thus the initial number of Astronomy and Astro-physics is "Number 101," forming part of "Volume XI."

It is stated that there are to be erected in Berlin three hundred "Urania pillars." These pillars will be about 18 feet high, made of cast iron, and will each contain a clock, meteorological instruments, weather charts, astronomical and geographical announcements, and also, as in the streets of Paris, a plan of the neighboring streets in enlarged form to enable strangers to find their way. The instruments are to be regulated from the observatory.

A star atlas by Herr Jacob Messer, of St. Petersburg, the page being about 4½ inches by 8¾ inches, will be found extremely convenient for amateur observers who do not care to burden themselves with the larger works. It contains all the stars visible to the naked eye (first to sixth magnitudes, inclusive), from the north pole down to 35° south declination, together with a selection of the most interesting double stars, variables, nebulæ, clusters, etc.

Much interesting light has been thrown of late on Babylonian astronomy by Fathers Epping and Strassmaier. A series of lunar and planetary observations has recently been found in the cuneiform tablets of the British Museum, and among others an observation of a lunar eclipse, one of the nine used by Ptolemy in his Almagest. Another work of the same authors shows that the Babylonians were able to predict the rising and setting of the moon, and the hour and magnitude of an eclipse.

Mr. A. M. W. Downing, superintendent of the computations at the Royal Observatory, Greenwich, was appointed to succeed Dr. Hind, who retired from the position of superintendent of the British Nautical Almanac office on January 1, 1892.

The Astronomische Gesellschaft held its fourteenth biennial meeting at Munich August 5–7, under the presidency of M. Gyldén. The society numbers 318 members.

A new astronomical society.—An association was formed in Berlin, in 1891, called the "Union of Friends of Astronomy and Cosmical Physics," for the purpose of securing co-operation in the study of these sciences in the countries of central Europe. The strength of the new society is perhaps best indicated by the names of its officers, Prof. Lehmann-Filhés being president, and Herrn Förster, M. W. Meyer, Plassmann, Jesse, Weinstein, and Reimann the presidents of its six sections.

The question of the ownership of an aerolite has been referred for settlement to the courts, and the decision reached is of some interest. On May 2, 1890, an aerolite weighing 66 pounds fell on the land of John Goddard, in Winnebago County, Iowa. It was dug up by Peter Hoagland, carried to his house, and sold for $105. Goddard claimed it as it had fallen on his land, while Hoagland claimed it as he discovered it and as it fell from heaven. In the suit that resulted the court held that the stone became part of the soil on which it fell, and that Hoagland had no right to remove it. The defense claimed that whatever was movable and found on the surface of the earth unclaimed by any owner was supposed to be abandoned by the proprietor.

NECROLOGY OF ASTRONOMERS, 1891-92.

ADAMS (JOHN COUCH). Born near Launceston, Cornwall, June 5, 1819; died at Cambridge, England, January 21, 1892.

AIRY (GEORGE BIDDELL). Born at Alnwick, July 27, 1801; died at Greenwich, January 2, 1892.

BRÜNNOW (FRANZ FRIEDRICH ERNST). Born at Berlin, November 18, 1821; died at Heidelberg, August 20, 1891.

CLARK (GEORGE BASSETT). Born at ———, February 14, 1827; died at Cambridgeport, December 30, 1891.

DE GASPARIS (ANNIBALE). Born at Bugnara, November 9, 1819; died at Naples, March 21, 1891.

GAUTIER (EMILE). Born at Geneva, April 18, 1822; died at Geneva, February 25, 1891.

GRANT (ROBERT). Born at Grantown-on-Sprey, June 17, 1814; died at Grantown, October 24, 1892.

HARTNUP (JOHN). Born in London, 1811; died at Liverpool, April 21, 1892.

VON HAYNALD (LUDWIG). Born at Szécsény, 1816; died at Kalocsa, July 4, 1891.

KLEIBER (JOSEPH). Born at St. Petersburg, December 15, 1863; died at Nice, February 12, 1892.

MOUCHEZ (AMÉDÉE ERNEST BARTHÉLEMY). Born at Madrid, August 24, 1821; died at Wissons, June 29, 1892.

POGSON (NORMAN ROBERT). Born at Nottingham, March 23, 1829; died at Madras, June 23, 1891.

RUTHERFURD (LEWIS MORRIS). Born at Morrisania, November 25, 1816; died May, 30, 1892.

SCHÖNFELD (EDUARD). Born at Hildburghausen, December 22, 1828; died at Bonn, May 1, 1891.

SEYDLER (AUGUST). Born at Senftenberg, June 1, 1849; died at Prag, June 22, 1891.

ASTRONOMICAL BIBLIOGRAPHY FOR 1891 AND 1892.

The following bibliography or index catalogue is arranged upon the plan adopted in the review of astronomy for 1886, thus making this series of indexes complete from that year to 1892, except for the year 1890, an index for which was published in the *Sidereal Messenger* for 1891 (vol. 10, pp. 84, 356).

The principal books, memoirs, and journal articles published in 1891 and 1892 that have come under the compiler's notice are here included, and there are also a few titles that belong to earlier years but were not found in time to insert in previous lists. References to series of observations, preliminary orbits of comets and asteroids, reviews, etc., are omitted, and to condense it into reasonable limits the bibliography has not been made exhaustive even to the extent of printing all titles that were originally collected.

The subject headings are in alphabetical order, with a subarrangement by authors. The references to periodicals are by volume and page separated by a colon; thus: Obsry. 15:173–89 indicates volume 15, pages 173 to 189, of *The Observatory*.

The following is a list of the principal periodicals examined:

American Journal of Science, vols. 141–144.
Astronomical Journal, Nos. 233–283.
Astronomische Nachrichten, Nos. 3010–3139.
L'Astronomie, vols. 10 and 11.
Astronomy and Astrophysics, vol. 11.
Bulletin Astronomique, vols. 8 and 9.
Comptes Rendus, vols. 112, 113, 114, 115.
Journal of the British Astronomical Association.
Monthly Notices of the Royal Astronomical Society, vols. 51, No. 3, to vol. 52, No. 9.
The Observatory, vols. 14, 15.
Publications of the Astronomical Society of the Pacific, Nos. 13 to 26.
Sidereal Messenger, vol. 10.
Vierteljahrsschrift der Astronomischen Gesellschaft, 26.–27. Jahrg.

ABBREVIATIONS.

Abstr. = Abstract.
Am. = American.
Bd. = Band.
d. = di, der, del, etc.
ed. = edition.
Hft. = Heft.
hrsg. = herausgegeben.
il. = illustrated.
j., jour. = journal.
k. k. = kaiserlich-königlich.
Lfg. = Lieferung.
n. d. = no date.
n. p. = no place of publication.
n. F. = neue Folge.
n. s. = new series.
Not. = Notices.
Obsry. = Observatory.
p. = page.
pl. = plates.
portr. = portraits.
pt. = part.
r. = reale.
Rev. = Review.
s. = series.
sc. = science, scientific.
vol. = volume.

Abastuman Observatory.

VON GLASENAPP (S.) [Opening.] Astron. Nachr., 130: 223. 1892.

See, also Compt. Rend. 115: 865. 1892.

Aberration (Constant of).

COMSTOCK (G. C.) Provisional results of a determination of the constant of aberration. Astron. Jour., 11: 161–6. 1892.

KÜSTNER (F.) Bestimmung der Aberrations-constante aus Meridian-Zenithdistanzen unabhängig von den Schwankungen der Polhöhe. Astron. Nachr., 126: 233–48. 1891.

LOEWY (M.) and PUISEUX (P. H.) Détermination de la constante de l'aberration. Compt. Rend., 112: 549, 1089. 1891.

ROSZEL (B. M.) & ANNIS (B. S.) Solution of Struve's equations for the determination of the aberration, taking into account the possible variability of the latitude. Astron. Jour., 12: 9–11. 1892.

Adams (John Couch). [1819–'92.]

DOWNING (A. M. W.) [Biographical sketch.] Vrtljschr. d. astron. Gesellsch., 27: 168–71. 1892.

GLAISHER (J. W. L.) [Biographical sketch.] Obsry., 15: 173–89. 1892.

For Biography, see, also, J. Brit. Astron. Assn.,2 :196, 1892. *Also:* Month. Not 53:184–209, 1892. *Also:* Astron. Jour., 11:112, 1892.

For Portrait, see J. Brit. Astron. Assn., 2; *Also*, Obsry., 15, 1892.

Airy. (George Biddle). [1801–'92.]

DUNKIN (E.) [Biographical sketch of] Sir George Biddle Airy. Obsry., 15: 74–94. 1892. Portr.

TURNER (H. H.) [Biographical sketch.] Astron. Nachr., 129: 33–8. 1892.

For Biography, see Astron Jour., 11: 96; *Also*: Compt. Rend 114: 91. 1892; *Also:* J. Brit. Astron. Assn., 2: 193–5; *Also:* Month. Not., 52, 212:29. 1892.

For Portrait, see Obsry., 15; *Also:* J. Brit. Astron. Assn., 2. 1892.

Alabama University Observatory.

[DESCRIPTION.] il. Pub. Astron. Soc. Pacific, 3: 110. 1891.

Algol. *See* Variable stars.

Altazimuth.

CHRISTIE (W. H. M.) New form of altazimuth. Month. Not., 52: 480–4. 1892.

Asteroid 8.

DOWNING (A. M. W.) Orbit of Flora. Month. Not., 52: 585–96. 1892.

Asteroid 80.

GROEBEN (———). Resultate einer neuen Bahnbestimmung des Planeten 80, Sappho. Astron. Nachr., 131 :153. 1892.

Asteroid 143.

VON HAERDTL (E.) Elemente und Ephemeride. Astron. Nachr., 128: 193–8. 1891.

Asteroids.

BACKLUND (O.) Bewegung einer gewissen Gruppe der kleinen Planeten. 54 p. 4to. St. Petersb. 1892.

BERBERICH (A.) Bahnneigung der kleinen Planeten. Astron. Nachr., 129: 265. 1892.

KIRKWOOD (D.) Groups of asteroids. Astron. and Astrophys, 11: 785–9. 1892.

———. Similarity of certain orbits. Pub. Astron. Soc. Pacific, 3: 95. 1891.

KRUEGER (A.) Notiz betr. die Nummerirung der kleinen Planeten. Astron. Nachr., 130: 159. 1892.

NOTATION for the asteroids. Astron. Jour., 12: 15, 55. 1892.

WOLF (M.) Photographische Aufnahmen von kleinen Planeten. Astron.Nachr., 129: 338–42. 1892.

Asteroids of 1890.

LEHMANN (P.) Zusammenstellung der Planeten-Entdeckungen im Jahre 1890. Vrtljschr. d. astron. Gesellsch, 26: 59–65. 1891.

Asteroids of 1891.

LEHMANN (P.) Zusammenstellung der Planeten-Entdeckungen im Jahre 1891. Vrtljschr. d. astron. Gesellsch, 27: 52–9. 1892.

Astrology.

DAUBRÉE (A.) L'astrologie et les métaux. L'Astron., 10: 363–73. 1891.

Astronomers.

MARKWICK (E. E.) Evolution of an amateur astronomer. J. Brit. Astron. Assn., 2: 496–504. 1892.

Astronomical Society of the Pacific.

HOLDEN (E. S.) Address of the retiring president . . . Mar. 28, 1891. Pub. Astron. Soc. Pacific, 3: 103–10. 1891.

PIERSON (W. M.) Address of the retiring president . . . Mar. 26, 1892. Pub. Astron. Soc. Pacific, 4: 51–8. 1892.

Astronomy.

BALL (R. S.) In Starry Realms. 10+371 p. il 8vo. London, 1892.

——. Star-Land. Being talks with young people about the wonders of the heavens. 8 + 376 p. 12mo.

CHAMBERS (G. F.) Pictorial astronomy for general readers. 15 + 268 p. 8vo. London, 1891.

CLERKE (A. M.) System of the stars. *Rev.* by Hale (G. E.). Pub. Astron. Soc. of the Pacific, 3: 180–94. 1891.

DENNING (W. F.) Telescopic work for starlight evenings, 11 + 361 p. il. 8vo. London, 1891.

GORE (J. E.) Star groups: a student's guide to the constellations. 8vo. Maps. London, 1891.

LANGLEY (S. P.) The new astronomy. New ed. 8vo. Boston, 1891.

MARKWICK (E. E.) Naked-eye astronomy. J. Brit. Astron. Assn., 1: 188–94. 1891.

WARREN (H. W.) Recreations in astronomy with directions for practical experiments in telescopic work.

WOLF (R.) Handbuch der Astronomie, ihrer Geschichte und Litteratur. Band. 1. 16 + 712 p. il. 8vo. Zürich, 1891.

YOUNG (C. A.) Lessons in astronomy, including Uranography, 10 + 358 p. il. 8vo. Boston, 1891.

Astronomy (Bibliography of).

COPELAND (R.) Catalogue of the Crawford library of the Royal Observatory, Edinburgh. 497 p. 4to. Edinb. 1890.

VON GELDERN (O.) Catalogue of the library of the Astronomical Society of the Pacific and of the Alexander Montgomery Library. Pub. Astron. Soc. Pacific, 3: 303–32. 1891.

TATLOCK (J.) Index to "Copernicus." Trans. N. Y. Acad. Sc., 10: 87–102. 1891.

WINLOCK (W. C.) Brief bibliography of astronomical literature for the year 1890, January to June. Sid. Mess., 10: 83–9. 1891.

——. Brief bibliography of astronomical literature for the year 1890, July to December. Sid. Mess., 10: 356–62. 1891.

Astronomy (History of).

BROWN (R.) jr. Euphratean stellar researches. Proc. Soc. Biblical Archæol, 14: 280–304. 1892.

CHAMBERS (G. F.) History of astronomy. Sid. Mess. 10: 457–62. 1891.

Astronomy (History of)—Continued.

EPPING (J.) and STRASSMAIER (J. N.) Babylonische Mondbeobachtungen aus den Jahren 38 und 79 der Seleuciden Aera. Ztschr. f. Assyriol. 7:220–54. 1892.

RUDLOFF (G.) & HOCHHEIM (A.) Die Astronomie des Mahmûd ibn Muhammed ibn Omar al Gagmini. Ztschr. d. Deutsch. Morgenländisch Gesellsch. 27 (Hft. 2). 213–75. 1892.

WITTSTEIN (A.) Historisch-astronomische Fragmente aus der orientalischen. Literatur. 30 p. 1 pl. 8 . 1892.

Astronomy (Practical).

CAMPBELL (W. W.) Handbook of practical astronomy. 168 p. 8 . Ann Arbor, 1892.

Astronomy (Progress of).

ASTRONOMY in 1890. Sid. Mess., 10: 133–6. 1891.

BOUQUET DE LA GRYE (J. J. A.) Progrès de l'astronomie en 1891. L'Astron. 11: 180–8. 1892.

NOTES on some points connected with the progress of astronomy during the past year [1890]. Month. Not., 51: 237–265. 1891.

NOTES on some points connected with the progress of astronomy during the past year [1891]. Month. Not., 52: 270–304. 1892.

REPORT of the council on the progress of astronomy during the year ending September 30, 1891. J. Brit. Astron. Assn., 2: 7–25. 1891.

REPORT of the council on the progress of astronomy during the year ending September 30, 1892. J. Brit. Astron. Assn., 3: 10–27. 1892.

Astronomy (Theoretical).

KLOOCK (H.) Studien zur theoretischen Astronomie. 1 Heft. 20 p. 8vo. Wilster, 1891.

SOUCHON (A.) Traité d'astronomie théorique, contenant l'exposition du calcul des perturbations planétaires et lunaires, etc. 504 p. 8vo. Paris, 1891.

WATSON (J. C.) Theoretical astronomy. Errata by W. W. Campbell. Pub. Astron. Soc. Pacific, 3: 87–91. 1891.

Atmosphere.

See also Refraction.

MULLER (G.) Photometrische und spectroskopische Beobachtungen angestellt auf dem Gipfel des säntis. 101 p. 3 pl. 4to. Potsdam, 1891.

Pub. d. Astrophys Obs. zu Potsdam. No. 27; (Bd. 8 Stück 1). *Rev. by* Safarik (A.) Vrtljschr. d. astron. Gesellsch. 27: 243–55. 1892.

Aurora.

BIGELOW (F. H.) New aurora-inclinometer. Sid. Mess., 10: 496. 1891

——. Reply to Professor Nipher on "The theory of the solar corona." Am J. c., 141: 505–7. 1891.

——. Solar corona; an instance of the Newtonian potential function in the case of repulsion. Am. J. Sc., 142: 1–11. 1891.

——. Solution of the aurora problem. Am. J. Sc., 141: 83–9. 1891.

Azimuth.

JACOBY (H.) Determination of azimuth by elongations of Polaris. Month. Not., 52: 106. 1891.

Baltimore Astronomical Society.

[Organization.] Astron. and Astrophys., 11: 789. 1892.

Binary stars. *See, also,* DOUBLE STARS.

BURNHAM (S. W.) New binary stars β 416, Scorpii 185. Sid. mess., 10: 489–91. 1891.

——. New binary star β 208. Astron. and Astrophys, 11: 461. 1892.

GORE (J. E.) Catalogue of binary stars for which orbits have been computed. Proc. Roy. Irish Acad., v. 1, No. 4.

Also Reprint.

Binary stars—Continued.

MONCK (W. H. S.) Spectra of binary stars. Astron. and Astrophys., 11:326. 1892.

PICKERING (E. C.) Close binary stars. Sid. Mess., 10: 5. 1891.

SEE (T. J. J.) Eccentricities of the orbits of binary stars. Sid. Mess., 10: 65–7. 1891.

VOGEL (H. C.) Beobachtungen der auf spectrographischem Wege aufgefundenen Binären Systeme β Aurigae und ζ Ursae majoris auf dem Potsdamer Observatorium. Astron. Nachr., 126: 265–72. 1891.

Brünnow (Franz Friedrich Ernst) [1821–'91].

KRUEGER (A.) Todes-Anzeige. Astron. Nachr., 128: 205–8. 1891.

For *Biography, see also*, Pub. Astron Soc. Pacific, 3: 367. 1892. *Also*, Month. Not., 52: 230 1892.

For *Portrait, see* Pub. Astron. Soc. Pacific, 3.

Calendar.

FLAMMARION (C.) Curiosités du calendrier. il. L'Astron., 11: 20–5. 1892.

MCFARLAND (R. W.) A perpetual calendar. Sid. Mess., 10: 129–31. 1891.

SERVIER (—.) Calendrier perpétuel. L'Astron., 11: 260–5. 1892.

Camphausen (Gottfried Ludolph) [1803–'90].

VOGEL (H. C.) Todes-Anzeige. Astron. Nachr., 126: 343. 1891.

Capodimonte Observatory.

ANGELITTI (F.) Nuova determinazione della latitudine del R. Osservatorio di Capodimonte. Astron. Nachr., 130: 429–31. 1892.

Carleton College Observatory.

PAYNE (W. W.) [Description of the observatory and instruments.] il. Pub. Astron. Soc. Pacific, 3: 85–7. 1891.

Chamberlin Observatory.

[DESCRIPTION.] Sid. Mess., 10: 400. 1891.

Chronology.

LYNN (W. T.) Ancient chronology and eclipses. Astron. Jour., 11: 43, 82. 1891.

STOCKWELL (J. N.) Eclipses and chronology. Astron. Jour., 11: 57–9. 1891.

——. Rectification of chronology by means of ancient eclipses. Astron. Jour., 10: 185; 11: 5, 28. 1891.

——. Supplement to recent contributions to chronology and eclipses. Astron. Jour., 12: 121–5. 1892.

Chronometers.

LEUSCHNER (A. O.) Thermometric chronometer of the Lick Observatory. Pub. Astron. Soc. Pacific, 3: 177–80. 1891.

Circle divisions.

BRUNS (H.) Untersuchung einer Wanschaff'schen Theilung. Astron. Nachr., 130: 17–42. 1892.

Clark (George Bassett) [1827–'91].

BRASHEAR (J. A.) [Biographical sketch.] Astron. and Astrophys., 11: 367–72. 1892.

For *Portrait, see Ibid.*

Collimation.

UPDEGRAFF (M.) Method for determining the collimation of the portable transit instrument. Astron. Jour., 10: 169. 1891.

Collimators.

TURNER (H. H.) Observations for coincidence of the collimators through the cube of the transit circle, Greenwich. . . Month Not., 52: 146–53. 1891.

Colored stars.

FRANKS (W. S.) *and others.* Determination of star colors. J. Brit. Astron. Assn., 1: 301–4. 1891.

Colored stars—Continued.

Levander (F. W.) Determination of the colors of stars. J. Brit. Astron. Assn., 1: 195–7. 1891.

Comet Brorsen.

Lamp (E.) Der Brorsen' sche, Comet. 1. Theil: die Verbindung der Erscheinungen 1873 und 1879 und die Vorausberechnung für 1890. 68 p. 4to. Kiel. 1892.
Pub. d. k. Sternw in Kiel. 7.

Comet Encke.

Backlund (O.) Calculs et recherches sur la comète d'Encke. Partie I: Tables pour le calcul de l'anomalie excentrique et du logarithme du rayon-vecteur. 60 p. 4to. St. Pétersb. 1892.

Comet Temple-Swift.

Bossert (J.) Retour de la comète en 1891. Bull Astron., 8: 185–91. 1891.

Comet 1402.

Helmolt (—.) Comet vom Frühjahr 1402. Astron. Nachr., 129: 301–6. 1892.

Comet 1689.

Holetschek (J.) [Bahn der] Cometen des Jahres 1689. Astron. Nachr., 129: 323–8. 1892.

Comet 1840 I.

Rechenberg (G.) Definitive Bahnbestimmung des Cometen 1840 I. Astron. Nachr., 131: 249–60. 1892.

Comet 1840 IV.

Schultz-Steinheil (C. A.) Definitive Bahnelemente. . . 28 p. 4to. Stockholm, 1891.

Comet 1857 III.

König (R.) Bestimmung der Bahn des Cometen 1857 III. Astron. Nachr., 128: 385–92. 1891.

Comet 1867 I.

Becker (L.) Orbit of the periodic comet 1867 I. Month Not., 51: 475–94. 1891.

Comet 1873 VII.

Schulhof (L.) [Orbite de] la comète 1873 VII. Bull. Astron., 9: 118–21. 1892.

Schulhof (L.) and Bossert (J.) [Identité des comètes 1873 VII et 1818 I.] Bull. Astron., 8: 24-6. 1891.

Comet 1881 VIII.

Coniel (J.) [Orbite de la comète 1881 VIII.] Bull. Astron., 9: 441–55. 1892.

Comet 1882 II.

Kreutz (H.) Untersuchungen über das System der Cometen 1843 I, 1880 I, und 1882 II. Theil II. Der grosse September. Comet 1882 II. (Fortsetzung.) 67. p. 4to. Kiel, 1891. Pub. d Kiel Strnwrt. 6.

Comet 1885 III.

Gallenmüller (J.) Definitive Bahnelemente . . . Astron. Nachr., 130: 345–64. 1892.

Comet 1886 IV.

Oppenheim (S.) Bahn des periodischen Cometen 1886 IV (Brooks.) Astron. Nachr., 128: 297–306. 1891.

Comet 1887 III.

Heinricius (P. A.) Definitive Bahnelemente des Cometen 1887 III. Astron. Nachr., 128: 161–70. 1891.

Comet 1887 IV.

Abetti (A.) Orbita della cometa 1887 IV. Astron. Nachr., 126: 177–211. 1891.

Comet 1887 IV—Continued.

CHANDLER (S. C.) [Comparison of Abetti's and Muller's orbits.] Astron. Jour., 10: 166. 1891.

Comet 1889 V.

CHANDLER (S. C.) Definitive orbits of the companions of comet 1889 V. Astron. Jour., 10: 153–63. 1891.

POOR (C. L.) Action of Jupiter . . . Astron. Jour., 11: 30. 1891.

Comet 1890 II.

BIDSCHOF (F.) Bestimmung der Bahn . . . 18 p. 8vo. Wien, 1891.

Comet 1890 IV.

BARNARD (E. E.) Strange astronomical coincidence. Sid. Mess., 10: 18. 1891.

Comet 1890 VII.

TENNANT (J. F.) Orbit of Spitaler's comet. Month Not., 52: 29. 1891.

Comet 1892 I.

BARNARD (E. E.) Observations and photographs . . . Astron. and Astrophys. 11: 386–8. 1892.

Comets.

BARNARD (E. E.) Classification of the periodic comets by their physical appearance. Astron. Jour., 11: 46. 1891.

BERBERICH (A.) Bemerkung zu Deichmüller "Ueber die Vorausberechnung der Cometen-Helligkeiten" Astron. Nachr., 131: 75. 1892.

COAKLEY (G. W.) Tidal theory of the forms of comets. Astron. and Astrophys., 11: 177–89. 1892.

DEICHMÜLLER (F.) Photometrie der Cometen. Astron. Nachr., 131: 309. 1892.

——. Vorausberechnung der Cometen-Helligkeiten. Astron. Nachr., 131: 33–42. 1892.

HERZ (N.) Elektro-statische Hypothese der Cometenschweife. Astron. Nachr., 129: 345–52. 1892.

HOLETSCHEK (J.) Beobachtung und die Berechnung von Cometen-Helligkeiten. Astron. Nachr., 131: 239–46. 1892.

KIAER (H. J.) Théories des queues cométaires. Astron. Nachr., 126: 281–92. 1891.

KLEIBER (J.) Gesammtzahl der Cometen im Sonnensystem. Astron. Nachr., 130: 121–5. 1892.

KRUEGER (A.) Berechnung der Störungen der periodischen Cometen durch die der Sonne nahen Planeten. Astron. Nachr., 129: 65–74. 1892.

MONCK (W. H. S.) Comets and the galaxy. J. Brit. Astron. Assn., 2: 212–6. 1892.

NEWTON (H. A.) Capture of comets by planets, especially their capture by Jupiter. Am. J. Sc., 142: 183, 482. 1891. *Also* Reprint.

——. Capture of comets by planets. Astron. Jour., 11: 73–5. 1891.

Rev. by Lehmann-Filhés (R.) Vrtljschr. d. Astron. Gesellsch., 27: 180–6. 1892.

PLUMMER (W. E.) Cometary notes. Obsry., 15: 308, 339. 1892.

SCHULHOF (L.) Grandes perturbations des comètes périodiques. Bull. astron., 8: 225–51. 1891. *See also*, Ibid. 147, 191.

WOLF (M.) Notiz über photographirte Meteoriten und Cometen. Astron. Nachr., 129: 101. 1892.

Comets and meteors.

MONCK (W. H. S.) Further note on comets and meteors. Astron. and Astrophys., 11: 274–80. 1892.

Comets of 1890.

KREUTZ (H.) Zusammenstellung der Cometen-Erscheinungen des Jahres 1890. Vrtljschr. d. astron. Gesellsch., 26: 65–81. 1891.

Comets of 1890—Continued.

[List of comets of 1890.] Month. Not., 51: 238. 1891.

[List with elements.] Astron. Jour., 10: 176. 1891.

Comets of 1891.

Kreutz (H.) Zusammenstellung der Cometen-Erscheinungen des Jahres 1891. Vrtljschr. d. astron. Gesellsch., 27: 60–9, 1892.

[List of comets of 1891.] Month. Not., 52: 271–4. 1892.

[List with elements.] Astron. Jour., 11: 168. 1892.

Comets of 1892.

Campbell (W. W.) Comets of 1892 and their spectra. Pub. Astron. Soc. Pacific, 4: 248–50. 1892.

Comets (Orbits of.)

Kreutz (H.) Bericht über Cometen. Vrtljschr. d. astron. Gesellsch., 26: 306–8. 1891.

Schulhof (L.) Sur les grandes perturbations des comètes périodiques. Bull. astron., 8: 147, 191. 1891.

Weiss (E.) Berechnung einer Kometenbahn mit Berücksichtigung von Gliedern höherer Ordnung. Sitzungsber. d. k. Akad. d. Wessensch. Wien. math. naturw. cl. 100: 1132–50 (Abth 2 a).

Coördinates (Transformation of).

Franke (J. H.) Transformation rechtwinklig-sphärischer (geodätischer) Coordinaten auf neue Normalpunkte. Astron. Nachr., 126: 353–8. 1891.

Necker (K.) Transformation sphärischer Coordinaten. Astron. Nachr., 130: 49–54. 1892.

Corona.

Bigelow (F. H.) Extension of the corona and the details of its structure. Obsry., 14: 50–2. 1891.

——. Period of the rotation of the sun near the poles, as derived from the coronas of 1878 and 1879. Pub. Astron. Soc. Pacific, 3: 201–16. 1891.

——. Law of the solar corona. Pub. Astron. Soc. Pacific, 3: 34–9. 1891.

Charroppin (C. M.) Coronal extension. Pub. Astron. Soc. Pacific, 3: 26–30. 1891.

Pritchett (H. S.) Solar corona of Jan., 1889, from the photographs. il. Pub. Astron. Soc. Pacific, 3: 155–62. 1891.

Pupin (I.) Electrical discharges through poor vacua, and on coronoidal discharges. Astron. and Astrophys., 11: 483–96. 1892.

Schaeberle (J. M.) Some physical phenomena involved in the mechanical theory of the corona. Pub. Astron. Soc. Pacific, 3: 70–3. 1891.

Cosmogony.

Backhouse (T. W.) Structure of the sidereal universe. 21 p., 11 pl. 4to. Sunderland, 1891. Pubins West Herndon House Obsry., 1.

See (T. J. J.) Origin of the stellar systems. Sid. Mess., 10: 179–87. 1891.

Crowborough Observatory.

Roberts (I.) Isaac Robert's new observatory on Crowborough Hill, Sussex [Eng.]. Month. Not., 51: 118. 1891.

Defective illumination.

Anding (E.) Lichtvertheilung auf einer unvollständig beleuchteten Planetenscheibe. Astron. Nachr., 129: 377–88.

Domes.

Christie (W. H. M.) New dome to be erected at the Royal Observatory, Greenwich. il. Month. Not., 51: 436–8. 1891.

Double stars.

Burnham (S. W.) Companion of Aldebaran. Month. Not., 51: 311–3. 1891.

——. Companions to Regulus. Month. Not., 51: 460. 1891.

——. Double-star discoveries and measures made in 1891 with the 36-inch equatorial of the Lick Observatory. Astron. Nachr., 130: 257–342. 1892.

Double stars—Continued.

——. Invisible double stars. il. Month. Not., 51: 388–95. 1891.

——. Motion of 20 Draconis. il. Month. Not., 51: 459. 1891.

——. Motion of Σ 2525. Month. Not., 52: 97–100. 1891.

——. Note on . . . Σ 186. Sid. Mess., 10: 72. 1891.

——. Orbit of OΣ 269. Obsry., 14: 263. 1891.

——. Orbit of κ Pegasi (β 989). Month. Not., 51: 313–6. 1891.

——. Orbit of β Delphini. Sid. Mess., 10: 215. 1891.

——. Orbit of OΣ 285. Sid. Mess., 10: 273–5. 1891.

——. Proper motion of Σ 1321. Sid. Mess., 10: 168–71. 1891.

Comstock (G. C.) [Burnham's method of observing] double stars. Sid. Mess., 10: 277–9. 1891.

Glasenapp (S.) Bahn des Doppelsterns β 883. Astron. Nachr., 130: 409. 1892.

——. Bahn des Doppelsterns 8 Sextantis. Astron. Nachr., 130: 411–5. 1892.

——. Bestimmung der Bahn des Doppelsterns φ Ursæ Majoris. Astron. Nachr., 130: 415–22.

——. Orbit of 9 Argûs, β 101. Month. Not., 52: 546. 1892.

——. Orbit of the double star κ Pegasi, A. C. Month. Not., 52: 548. 1892.

——. Orbit of Σ 186. Astron. Jour., 11: 41, 71. 1891.

——. Orbit of β 612. Astron, and Astrophys, 11: 46. 1892.

Gore (J. E.) Orbit of OΣ 269. Month. Not., 52: 550. 1892.

——. Orbit of γ Coronæ Australis. Month. Not., 52: 503. 1892.

——. Orbit of γ Centauri. Month. Not., 52: 505. 1892.

——. Orbit of 37 Pegasi (Σ 2912). Astron. Nachr., 131: 137. 1892.

——. Orbit of Σ 2525. Month. Not., 53: 44. 1892.

Hall (A.) Notes on double stars. Astron. Jour., 12: 4, 33. 1892.

——. Relative motion of 61 Cygni. Astron. Jour., 11: 140. 1892.

Leavenworth (F. P.) Personal error in observations of position angle. Sid. Mess., 10: 116–9. 1891.

Lewis (T.) Orbit of 36 Andromedæ (Σ 73). Month. Not., 51: 462–6. 1891.

Pickering (E. C.) Discovery of double stars by means of their spectra. Astron. Nachr., 127: 155. 1891.

Powell (E. B.) Note on the orbit of α Centauri. Month. Not., 52: 506–8. 1892.

See (T. J. J.) Origin of the stellar systems. Obsry., 14: 115–22. 1891.

——. Great excentricities of the stellar orbits. Obsry., 14: 92–5. 1891.

Sellors (R. P.) Orbit of γ Coronæ Australis. Month. Not., 53: 45–7. 1892.

Vogel (H. C.) Remarks on Mr. Fowler's note on the duplicity of α Lyræ. Month. Not., 51: 104–8. 1891.

——. Periode von α Virginis. Astron. Nachr., 127: 255. 1891.

Double stars (Orbits of).

Rambaut (A. A.) Determination of double-star orbits from spectroscopic observations of the velocity in the line of sight. Month. Not., 51: 316–30. 1891.

——. Geometrical method of finding the most probable apparent orbit of a double star. 4 p., 2 pl., 8vo. Dublin 1891. Repr. from Proc. Roy. Soc. Dubl.

Earth.

Cornu (A.) Researches on the mean density of the earth. Month. Not., 51: 446. 1891.

Flammarion (C.) Comment arrivera la fin du monde. L'Astron., 11: 416, 457. 1892.

Haupt (P.) Momentanbewegungen der Erdaxe. Astron. nachr., 129: 249–58. 1892.

Earth (Orbit of).

Hall (A.), jr. Secular perturbations of the earth produced by the action of Mars. Astron. Jour., 11: 25–8. 1891.

Innes (R. T. A.) Secular perturbations of the earth's orbit by Mars. Month. Not., 52: 80, 479. 1891.

Eclipse of the Sun, 1889, Jan. 1.

Report of the observations made by the Washington university eclipse party at Norman, Cal....39 p. 7 pl. 4to. Cambridge, 1891.

Upton (W.) and Rotch (A. L.) Meteorological and other observations....at Willows, Cal. 34 p. il. 4to. Cambridge, 1892. Ann. Harv. Coll. Obsry., v. 29, No. 1.

Eclipse of the Sun, 1893, April 15-16.

Pritchett (H. S.) [Observing stations available.] Astron. and Astrophys., 11: 454–7. 1892.

Todd (D. P.) Data (chiefly meteorological) bearing upon the selection of [observing] stations. 24 p. 8vo. [n. p. 1892]. Repr. from Am. Meteorolog. J.

Eclipses.

Tisserand (F.) Movement de la lune et les plus anciennes éclipses. il. L'Astron., 11: 161–71. 1892.

Eclipses of the Moon.

Hartmann (J.) Vergrösserung des Erdschattens bei Mondfinsternissen. Abhandl. d. math.-phys. Cl. d. k. säch. Gesellsch. d. Wissen., 17: 365–553. 1891.

Rec. by Seeleger (H.) Vrtljschr. d. astron. Gesellsch., 27: 186–206. 1892.

Eclipses of the Sun.

Gruey (L. J.) Formules écliptiques de Hansen simplifiées et démontrées géométriquement. il. Bull. Astron., 9: 233, 286. 1892.

Electrical illumination.

Marcuse (A.) Einrichtung zur elektrischen Beleuchtung astronomischer Instrumente. Astron. Nachr., 130: 41. 1892.

Errors.

Czuber (E.) Theorie der Beobachtungsfehler. 12+418 p. 8vo. Leipzig 1891.

Rec. by Börsch (A.) Vrtljschr. d astron. Gesellsch., 27: 4–12. 1892.

Lehmann-Filhés (R.) Wahrscheinlichste Fehlervertheilungen. Astron. Nachr., 127: 305–15. 1891.

Veltmann (W.) Theorie der Beobachtungsfehler. Astron. Nachr., 131: 1–16. 1892.

Flexure.

Gruey (L. J.) Mesure directe de la flexion du limbe d'un cercle méridien par ses propres microscopes. il. Bull. Astron., 8: 67–72. 1891.

de Gasparis (Annibale) [1819–'92.]

Fergola (E.) Necrologia. Astron. Nachr., 129: 247. 1892.

Gautier (Émile) [1822–'91].

Wolf (R.) Necrolog. Vrtljschr. d. astron. Gesellsch., 26: 185–92.

For *biography* see, *also*, Astron. Nachr., 126: 383. 1891.

For *Portrait*, see Vrtljschr. d. astron. Gesellsch., 26.

Gegenschein.

Barnard (E. E.) Observations... made at Mount Hamilton, 1888–'91. Astron. Jour., 11: 19. 1891.

Goodsell Observatory.

Williams telescope of Goodsell Observatory. Sid. Mess., 10: 354, 376. 1891.

Grant (Robert) [1814–'92].

C. (R.) [Biographical sketch] Nature. 47: 36. (1892, Nov. 10.) *Also:* Astron. and Astrophys., 11: 878–80. 1892.

Gravity.

Mendenhall (T. C.) Determinations of gravity with half-second pendulums on the Pacific coast, in Alaska and at Washington, D. C., and Hoboken. 62 p. 8vo, Washington, 1882. App. 15. Rept. U. S. C. and G. Surv. 1891.

Harvard College Observatory.

EXPEDITION to the Southern hemisphere. Pub. Aston. Soc. Pacific, 3: 128. 1891.

FLEMING (M.) Harvard College Observatory astronomical expedition to Peru. Pub. Astron. Soc. Pacific, 4: 58–62.

PICKERING (E. C.) A large southern telescope. Astron. and Astrophys., 11: 783–5. 1892.

——. [Suggesting subscription for] a large southern telescope. 3p. 4to. Cambridge, 1892.

PICKERING (W. H.) Mountain station . . . [at Arequipa, Peru]. il. Astron. and Astrophys. 11: 353–62. 1892.

von Haynald (Ludwig) [1816–'91.]

FÉNYI (J.) Todesanzeige. Astron. Nachr., 128: 15. 1891.

Heliometer.

GILL (D.) Reduction of distances from heliometer observations. il. Astron. Nachr., 131: 185–92. 1892.

LORENTZEN (G.) Untersuchung der Scalen eines Heliometers. Astron. Nachr., 131: 217–38. 1892.

SCHUR (W.) Systematische Correctionen von Distanzmessungen am Heliometer. Astron. Nachr., 131: 381. 1892.

Interpolation.

FRISCHAUF (J.) Genauigkeit interpolirter Zahlen. Astron. Nachr., 130: 123. 1892.

RADAU (R.) Études sur les formules d'interpolation. Bull. Astron., 8: 273, 325, 376, 425. 1891.

Jupiter.

BARNARD (E. E.) Observations of the planet Jupiter and his satellites during 1890 with the 12-inch equatorial of the Lick Observatory. Month. Not., 51: 543–55. 1891.

——. Observations of the spots and markings . . . Month. Not., 52: 7–16. 1891.

CLERKE (A. M.) Jupiter and his system. 44 p. 8vo. London, 1892.

ELGER (T. G.) Recent disturbance in the northern hemisphere of Jupiter. Obsry., 15: 109–12. 1892.

FLAMMARION (C.) Découvertes récentes sur Jupiter. il. L'Astron., 11: 81–93. 1892.

HOLDEN (E. S.) and CAMPBELL (W. W.) Negatives of Jupiter made with the great telescope of the Lick Observatory during 1891. Month. Not., 52: 499.

KEELER (J. E.) Red spot on Jupiter. J. Brit. Astron. Assn., 1: 435. 1891.

LANDERER (J. J.) Les dimensions et la latitude jovicentrique de la tache rouge de Jupiter. Bull. Astron., 9: 246–8. 1892.

LEVEAU (S.) Determination de la masse de Mars et de la Jupiter par les observations méridiennes de Vesta. Compt. Rend. 112: 332–5. 1891.

PLASSMAN (J.) Der Planet Jupiter. Darstellung der wichtigsten Beobachtungsergebnisse und Erklärungsversuche. 116 p. il. Köln 1892.

SCHUR (W.) Untersuchung über die Figur des Planeten Jupiter. Astron. Nachr., 129: 10–14. 1892.

WILLIAMS (A. S.) Notes of a preliminary examination of photographs . . . taken at the Lick Observatory in 1891. il. Pub. Astron. Soc. Pacific, 4: 166–76. 1892.

——. Outburst of spots in the northern hemisphere of Jupiter. Obsry., 14: 361. 1891.

——. Red spot on Jupiter. J. Brit. Astron. Assn., 1: 436. 1891.

Jupiter—Continued.

——. Reduction of measures of the photographs . . . taken at the Lick Observatory in 1890. il. Month. Not., 51: 402. 1891.

Jupiter (Orbit of).

DOWNING (A. M. W.) Note on Damoiseau's "Tables écliptiques des satellites de Jupiter." Month. Not., 52: 573. 1892.

HILL (G. W.) Additional terms in the great inequalities of Jupiter and Saturn. Astron. Jour., 11: 49–51. 1891.

Jupiter (Satellites of).

BARNARD (E. E.) Discovery and observations of a fifth satellite to Jupiter. Astron. Jour., 12: 81–5. 1892. *Also:* Astron. Nachr., 131: 73. 1892.

——. Note on the period of the fifth satellite. Astron. Jour., 12: 103. 1892.

——. Note on the period and distance of the fifth satellite of Jupiter. Month. Not., 53: 36. 1892.

——. Some further observations of the fifth satellite . . . Obsry., 15: 425–7. 1892.

[DISCOVERY of a fifth satellite.] Pub. Astron. Soc. Pacific., 4: 199. 1892.

ENTDECKUNG eines fünften Jupiterstrabanten durch Barnard, 1892. Sept. 9. Astron. Nachr., 130: 375. 1892.

FREEMAN (A.) Siderial period of the new satellite of Jupiter. Month. Not., 53: 37–9. 1892.

VON HÆRDTL (E.) Inégalité du quatrième ordre provenant de l'action mutuelle des deux derniers satellites de Jupiter. Bull. Astron., 9: 212–6. 1892.

LYNN (W. T.) Nomenclature of the satellites of Jupiter. Obsry. 15: 427–9. 1892.

MARTH (A.) Data for computing the positions of the satellites of Jupiter, 1891; with tables of the inequalities. Month. Not., 51: 505–41. 1891.

——. Data for computing the positions of the satellites of Jupiter. 1892. Month. Not., 52: 574–80. 1892.

MICHELSON (A. A.) Measurement of Jupiter's satellites by interference. il. Pub. Astron. Soc. Pacific. 3: 274–8. 1891.

Karlsruhe Observatory.

VERÖFFENTLICHUNGEN . . . 4. Heft. 11+307 p. 4to. Karlsruhe, 1892.

Kenwood Observatory.

HALE (G. E.) [Description]. Pub. Astron. Soc. Pacific, 3: 30–4. 1891.

——. [Description.] il. Sid. Mess., 10: 321–3. 1891.

YOUNG (C. A.) [Address at the dedication.] Sid. Mess., 10: 312–21. 1891.

Kepler's problem.

PETERS (C. F. W.) Bemerkung zum Kepler'schen Problem. Astron. Nachr., 126: 291. 1891.

Kleiber (Joseph). [1865–'92.]

GLASENAPP (S.) Todesanzeige. Astron. Nachr., 129: 151. 1892.

Ladd Observatory.

ROGERS (W. A.) Address at the dedication . . . Sid. Mess., 10: 491. 1891.

UPTON (W.) [Description of building and instruments.] Sid. Mess., 10: 502–5. 1891.

Lamp (Johannes Christian). [1857–'91].

AUWERS (A.) Todesanzeige. Astron. Nachr., 128: 239. 1891.

BATTERMANN (H.) Nekrolog. Vrtljschr. d. Astron. Gesellsch., 27: 2. 1892.

Latitude.

BECK (A.) Anwendung eines Objectivprismas zur Zeit- und Polhöhenbestimmung. Astron. Nachr., 130: 81–96. 1892.

CORTI (J. S.) New method for the simultaneous determination of latitude and azimuth. Sid. Mess., 10: 189–94. 1891.

MARCUSE (A.) Anwendung photographischer Methoden für Polhöhenbestimmungen. Vrtljschr. d. Astron. Gesellsch., 27: 308–13. 1892.

Latitude (Variation of).

D'ABBADIE (A.) Fluctuation des latitudes terrestres. Bull. Astron., 9: 89–102. 1892.

ALBRECHT (T.) Provisorische Resultate der Beobachtungsreihen in Berlin, Potsdam und Prag. Astron. Nachr., 126: 145–58. 1891.

——. Resultate der fortgesetzten Beobachtungsreihen in Berlin und Prag. Astron. Nachr., 128: 129–36. 1891.

——. Resultate der Beobachtungsreihen in Berlin, Prag, Strassburg und Honolulu betreffend die Veränderlichkeit der Polhöhe. il. Astron. Nachr., 131: 169. 1892.

BAKHUYZEN (H. G. van de Sande). Variations of latitude deduced from the observations of Polaris made at Greenwich, 1851–1889. il. Month. Not., 51: 286–306. 1891.

BRENDEL (M.) Einfluss von Polschwankungen auf die geographische Lage der Erdorte. Astron. Nachr., 131: 59. 1892.

CHANDLER (S. C.) Variation of latitude. Astron. Jour., 11: 59, 65, 75, 83; 1891; 12: 17, 57, 65, 97. 1892.

——. Supposed secular variation of latitudes. Astron. Jour., 11: 107–9. 1892.

——. Note on secular variation of latitude. Astron. Jour., 11: 134. 1892.

——. On the Washington prime-vertical observations. Astron. Jour., 11: 174. 1892.

COMSTOCK (G. C.) Relation of the periodic and secular variations of the latitude. Astron. Jour., 11: 92, 116. 1892.

——. Secular variation of latitudes. Astron. Jour., 12: 24. 1892. *Also* Am. J. Sc., 142: 470–82. 1892.

——. Variations of latitude observed at the Washburn Observatory. Astron. Nachr., 127: 97–104. 1891.

DOOLITTLE (C. L.) Latitude of the Sayre Observatory. Astron. Nachr., 128: 213–8. 1891.

FLAMMARION (C.) Variabilité des latitudes. L'Astron., 10: 139–45. 1891.

GOULD (B. A.) Periodic variation of the latitude at Cordoba. Astron. Jour., 11: 129, 137. 1892.

HELMERT (F. R.) Erklärung der beobachteten Breitenänderungen. Astron. Nachr., 126: 217–24. 1891.

HERZ (N.) Herrn Folie's tägliche Polhöhenschwankung. Astron. Nachr., 127: 273. 1891.

——. Jährliche Veränderung der Polhöhen. Astron. Nachr., 126: 329–34. 1891.

JACOBY (H.) German variation of latitude work. Astron. and Astrophys., 11: 471–7. 1892.

KOSTINSKY (S.) Variations de la latitude de Poulkovo en 1891–1892. Astron. Nachr., 130: 251. 1892.

LAMP (J.) Niveauschwankungen der Oceane als eine mögliche Ursache der Veränderlichkeit der Polhöhe. Astron. Nachr., 126: 223–6. 1891.

MARCUSE (A.) Resultate der fortgesetzten Berliner Beobachtungsreihe betr. die Veränderlichkeit der Polhöhe. Astron. Nachr., 127: 37. 1891.

——. Ergebnisse der Expedition nach Honolulu zur Untersuchung der Polhöhenänderung. Astron. Nachr., 131: 297–302. 1892.

NEWCOMB (S.) Dynamics of the earth's rotation with respect to the periodic variations of latitude. Month. Not., 52: 336–41. 1892.

——. Law and the period of the variation of terrestrial latitudes. Astron. Nachr., 130: 1–6. 1892.

——. Periodic variation of latitude and the observations with the Washington prime-vertical transit. Astron. Jour., 11: 81. 1891.

——. Remarks on Mr. Chandler's law of variation of terrestrial latitudes. Astron. Jour., 12: 49. 1892.

Latitude (Variation of)—Continued.

THACKERAY (W. G.) and Turner (H. H.) Variation of latitude as indicated by recent observations at . . . Greenwich. Month. Not., 53: 2–11. 1892.

THOMSON (W.) Variations of short period in the latitude. Nature. (Dec. 3, 1891.) *Abstr.:* Pub. Astron. Soc., Pacific, 4: 33. 1892.

WANACH (B.) Schwankungen der Polhöhe von Pulkowa. 1890 und 1891. il. Astron. Nachr., 129: 329–34. 1892.

——. Ableitung der Polhöhenschwankungen aus älteren Pulkowaer Beobachtungen im ersten Vertical. Astron. Nachr., 130: 245–52. 1892.

Lenses.

BURNHAM (S. W.) New enlarging photographic lens. Astron. and Astrophys., 11: 558-62. 1892.

HOLDEN (E. S.) Who discovered the optical properties of lenses? Pub. Astron. Soc., Pacific, 3: 133–40. 1891.

Levels.

HALL (A.) The spirit level. Sid. Mess., 10: 187. 1891.

TURNER (H. H.) New forms of levels. Month. Not., 52: 52–6. 1891.

Lick Observatory.

HOLDEN (E. S.) Note on the early history of the Lick Observatory. il. Pub. Astron. Soc., Pacific, 4: 139-50. 1892.

——. The great telescope; its accomplishments for science during the past year. il. San Jose Daily Mercury, Jan. 1, 1892.

SHINN (M. W.) The Lick astronomical department of the University of California. 22 p. il. 8vo. San Francisco, 1892. *Repr. from:* Overland Month., Nov., 1892.

Light.

LANGLEY (S. P.) Energy and vision. il. Mem. Nat'l Acad. sc., 5: 7–18 (V. 5, 1 mem.). 1891.

Lunar theory.

BROWN (E. W.) Determination of a certain class of inequalities in the moon's motion. Month. Not., 52: 71–80. 1891.

——. Note on the lunar theory. Month. Not., 52: 408. 1892.

CAYLEY (A.) Note on the lunar theory. Month. Not., 52: 2–5. 1891.

DANCKVOORTT (A.) Die vom Monde verursachte atmosphärische Ebbe und Fluth in Bezug auf Entfernung und Stundenwinkel des Mondes. 54 p. 8vo. Magdeburg, 1891.

GORDON (J.) Corrections to Hansen's Tables de la lune. Month. Not., 53: 17-19. 1892.

RADAU (R.) Notes relatives à quelques points de la théorie de la lune. Bull. Astron., 9: 361–74. 1892.

——. Remarques sur certaines inégalités à longue période du mouvement de la lune. Bull. Astron., 9: 137, 185, 245. 1892.

STOCKWELL (J. N.) Mean and secular motion of the moon's perigee. Astron. Jour., 10: 145 1891.

STONE (E. J.) Verification of the expressions given in Delaunay's lunar theory by a direct differentiation and substitution in the differential equations. Month. Not., 52: 68–70. 1891.

TISSERAND (F.) Note sur l'état actuel de la théorie de la lune. Bull. Astron., 8: 481–503. 1891.

——. Accélération séculaire de la lune et sur la variabilité du jour sidéral. Compt. Rend. 113: 667–9. 1892.

TURNER (H. H.) Systematic errors of the moon in right ascension. Month. Not., 53: 11–16. 1892.

Mars.

BARNARD (E. E.) [Remarks on observations of 1892 at the Lick Observatory.] il. Astron. and Astrophys., 11: 680–4. 1892.

COMSTOCK (G. C.) Observations . . . at the Washburn Observatory. Astron. and Astrophys., 11: 679. 1892.

FLAMMARION (C.) [Dessins de] la planète Mars. L'Astron., 11: 321–31. 1892.

——. La planète Mars et ses conditions d' habitabilité: synthèse générale de toutes les observations. 4to il. Paris, 1892.

——. Nouvelles observations sur Mars. il. L'Astron., 10: 162–70. 1891.

——. Nouvelles observations sur la planète Mars. il. L'Astron., 11: 367, 441. 1892.

——. Retour de la planète Mars. il. L'Astron., 11: 201, 288. 1892.

——. Saisons sur la planete Mars. il. L'Astron., 10: 323–42. 1891.

——. Variations certaines observées sur la planète Mars. il. L'Astron. 10: 88–102. 1891.

HOLDEN (E. S.) Note on the Mt. Hamilton observations. . . June–Aug., 1892, il. Astron. and Astrophys., 11: 663–8. 1892.

PERROTIN (J.) Observations de la planète Mars. Compt. Rend., 115: 379–81. 1892.

PICKERING (W. H.) [Changes on] Mars. il. Astron. and Astrophys. 11: 668–75. 1892.

——. Colors exhibited by the planet Mars. Astron. and Astrophys., 11: 449, 545. 1892.

——. [Summary of observations at Arequipa, 1892.] Astron. and Astrophys., 11: 849–52. 1892.

SCHAEBERLE (J. M.) Preliminary note on the observations of the surface features . . . during the opposition of 1892. Pub. Astron. Soc., Pacific, 4: 196–8. 1892.

STONE, (E. J.) [Solar parallax from meridian observations of Mars, 1892.] Month Not., 52: 538–41. 1892.

TERBY (F.) Physical observations of Mars. Astron. and Astrophys., 11: 478–80. 1892. 555–8.

WILSON (H. C.) Observations . . . at Goodsell Observatory. il. Astron. and Astrophys., 11: 684, 1892.

WISLICENUS (W. F.) Physiche Beobachtungen des Mars während der Opposition, 1890. il. Astron. Nachr., 127: 161–8. 1891.

YOUNG (C. A.) Observations . . . at . . . Princeton. Astron. and Astrophys., 11: 675–8. 1892.

Mars (Diameter of).

TISSERAND (F.) Sur le diamètre de Mars. Bull. Astron., 9: 417–22. 1892.

Mars (Orbit of).

VON HAERDTL (E.) Note sur trois inégalités à longue période du mouvement de Mars. Bull. Astron., 9: 409–17. 1892.

Mars (Satellites of).

COPELAND (R.) Pretended early discovery of a satellite of Mars. Month Not., 52: 493. 1892.

Mechanics (Celestial).

LEHMANN-FILHÉS (R.) Zwei Fälle des Vielkörperproblems. Astron. Nachr., 127: 137–44. 1891.

POINCARÉ (H.) Méthodes nouvelles de la mécanique céleste. 2 vol. 8vo. Paris. 1892.

——. Developpement approché de la fonction perturbatrice. Compt. Rend., 112: 269–73. 1891.

SEELIGER (H.) Ueber allgemeine Probleme der Mechanick des Himmels: 29 p. 4to. München, 1892.

Mechanics (Celestial)—Continued.

Wand (T.) Integration der Differentialgleichungen welche die Bewegungen eines Systems von Punkten bestimmen. Astron. Nachr., 127: 353–60. 1891. 130: 377–90. 1892.

Mercury.

Trouvelot (E. L.) Observations sur les planètes Vénus et Mercure. 87 p. il. 8vo. [Par. 1892?]

Mercury (Diameter of).

Ambronn (L.) Beitrag sur Bestimmung des Mercurdurchmessers. Astron. Nachr., 127: 157–62. 1891.

Mercury (Orbit of).

Harzer (P.) Bewegung des Mercurperihels. Astron. Nachr., 127: 81–8. 1891.

Meridian circle observations.

Safford (T. H.) How to make good meridian observations. Sid. Mess., 10: 113, 209, 401. 1891.

Meridian marks.

Gruey (L. J.) Transformation des mires meridiennes. Bull. Astron., 8: 321–5. 1891.

Meridian (Prime).

New origin for terrestial longitudes. Sid. Mess., 10: 269–71. 1891.

Meteors.

Callandreau (O.) Theorie des étoiles filantes. Compt. Rend., 112: 1303–5. 1891.

Coakley (G. W.) Probable origin of meteorites. Astron. and Astrophys. 11: 753–63. 1892.

Denning (W. F.) Meteor radiants. Sid. Mess., 10: 234. 1891.

——. Physical nature of shooting stars and aerolites. Astron. and Astrophys, 11: 481. 1892.

Kleiber (J.) Displacement of the apparent radiant points of meteor showers due to the attraction, rotation and orbital motion of the earth. Month Not., 52: 341–54. 1892.

——. Opredelenije orbit meteornych potokof. [On the determination of orbits of meteor streams.] 8+322 p. 8°. St. Petersb., 1891

Rev. by Harzer (P.) Vrtljschr d. Astron. Gesellsch. 26: 193–219. 1891.

Monck (W. H. S.) August meteors. Pub. Astron. Soc., Pacific, 3: 114. 1891.

——. Orbits of meteors. Sid. mess., 10: 328–31. 1891.

——. Radiant points of meteor showers. Pub. Astron. Soc., Pacific, 4: 217–24. 1892.

Plassmann (J.) Zweites Verzeichniss von Meteorbahnen. 30 p. 8vo. Köln, 1891.

von Niessl (G.) Periheldistanzen und andere Bahnelemente jener Meteoriten deren Fallerscheinungen mit einiger Sicherheit beobachtet werden konnten. 77 p. 8vo. 1891.

Micrometers.

Fabritius (W.) Kreuzstab-mikrometer. Astron. Nachr., 129: 51–56. 1892.

Hamy (M.) & Boquet (F.) Flexion des fils micro métriques. Bull. Astron., 8: 97–101. 1891.

Poynting (J. H.) Parallel plate double image micrometer. Month. Not., 52: 556–60. 1892.

Schur (W.) Bemerkung zu dem Aufsatze von Dr. Wislicenus. Ueber den Einfluss von Ring-und Scheibenblenden auf Mikrometer messungen . . . Astron. Nachr., 129: 241. 1892.

Wellmann (V.) Neue Form des Ring-und Rauten-Mikrometers. Astron. Nachr., 127: 265–70. 1891.

Micrometers—Continued.

WISLICENUS (W. F.) Einfluss von Ring-und Scheibenblenden auf Mikrometer Messungen. Astron. Nachr., 128: 345-58, 1891.

Milky Way.

BOEDDICKER (O.) The Milky Way from the north pole to 10° of south declination . . . folio. London, 1892.

Rev: J. Brit. Astron. Assn. 2: 200. 1892.

MARTH (A.) Galactic longitudes and latitudes of the brighter stars in a zone of the heaven, containing the Milky Way. Month. Not., 53: 74-109. 1892.

Mirrors.

COMMON (A. A.) Silvering glass mirrors. Astron. and Astrophys., 11: 852-9. 1892.

WAUGH (W. R.) Dewing of mirrors. J. Brit. Astron. Assn., 2: 130. 1891.

Mont Blanc Observatory.

JANSSEN (J.) [Note sur l'observatoire de Mont Blanc.] Compt. Rend., 113: 179, 571. 1891; 114: 195. 1892; 115: 914-9. 1892.

Moon. (*See also* Lunar theory.)

BOEDDICKER (O.) Lunar radiant heat measured at Birr Castle observatory during the total eclipse of January 28, 1888. 32 p. il. 4to. Dublin, 1891.

Repr. from Trans. Roy. Dubl. Soc. 2. s. 4: 481-512.

ELGER (T. G.) Lunar work for amateurs. Pub. Astron. Soc. Pacific, 3: 162-72. 1891.

——. The lunar walled-plain Ptolemaus. il. J. Brit. Astron. Assn., 1: 305-13. 1891.

FLAMMARION (C.) La lune à 48 kilomètres. L'Astron., 11: 389-91. 1892.

H[OLDEN] (E. S.) Examination of the Lick Observatory negatives of the moon. Pub. Astron. Soc. Pacific, 3: 249, 252, 285. 1891. 4: 78, 96. 1892.

——. Photographs of the moon made with the great telescope at the Lick Observatory. 6 p. il. 8vo. [n. p. n. d.] *Repr. from*: Overland Month. Jan. 1892.

——. The lunar crater Copernicus. il. Pub. Astron. Soc. Pacific, 4: 114-20. 1892.

MARTH (A.) List of published lunar sketches and photographs arranged according to the sun's position. Month. Not., 51: 164-76. 1891.

PEAL (S. E.) Comparative selenology. J. Brit. Astron. Ass'n., 1: 244-9. 1891.

PICKERING (W. H.) Are there at present active volcanoes on the moon. il. Obsry., 15: 250-4. 1892.

——. Investigation of the systems of bright streaks visible upon the full moon. Astron. Nachr., 130: 225. 1892.

——. Lunar atmosphere and the recent occultation of Jupiter. il. Astron. and Astrophys, 11: 778-82. 1892.

SPRAGUE (R.) Notes on the Lick Observatory lunar photographs. Obsry., 15: 254-6. 1892.

VERY (F. W.) Prize essay on the distribution of the moon's heat and its variation with the phase. 45 p. [11 pl.] 4to. The Hague, 1891.

WEINEK (L.) Enlarged drawings from lunar photographs taken at the Lick Observatory. il. Pub. Astron. Soc. Pacific, 3: 333-45. 1891.

——. Neue Rille und neuer Krater entdeckt auf den Mondphotographien der Lick Sternwarte. Astron. Nachr., 128: 139-42. 1891.

——. Photographische Entdeckung eines Mondkraters im Mare Nubium, und optischer Nachweis desselben. Astron. Nachr., 131: 159. 1892.

——. Photographic discovery of a new crater. Pub. Astron. Soc. Pacific, 4: 177-9. 1892.

YOUNG (C. A.) Index map of the moon. il. Pub. Astron. Soc. Pacific, 3: 20. 1891.

Google

Mouchez (Amedée Ernest Barthélemy) [1821–'92.]

Klumpke (D.) [Biographical sketch.] Obsry. 15: 305–7. 1892.

For Biography, see also Bull. Astron., 9: 281-5. 1892. Also: L'Astron. 11: 281. 1892. *For Portrait see* Bull astron. 9:281 (Juillet 1892.)

Nadirinstrument.

Beck (A.) Neues Instrument zur Zeit-und Polhöhenbestimmung. il. Astron. Nachr., 126: 385–95. 1891.

Nebula in Andromeda.

Roberts (I.) Photographic evidence of variability in the nucleus of the great nebula in Andromeda. Month. Not., 51: 116–8. 1891.

Nebula in Lyra.

Keeler (J. E.) Central star of the ring nebula in Lyra. Astron. Nachr., 130: 227. 1892.

Nebula in Orion.

Ambronn (L.) Ausmessung des Trapezes im Orionnebel. Astron. Nachr., 130: 97–112. 1892.

Holden (E. S.) The nebula of Orion. 8 p. il. 8vo [San Francisco, 1892.] *Repr. from*: Overland Month. Apr., 1892.

Naegamvala (K. D.) Character of the chief line of the nebula in Orion. Month. Not., 51: 442. 1891.

Nebulæ.

Archenhold (F. S.) Ausgedehnter Nebel bei ζ Persei. Astron. Nachr., 129: 153–8. 1892.

Barnard (E. E.) Two probably variable nebulæ. Astron. Nachr., 130: 7. 1892.

Bigourdan (G.) Observations de nebuleuses et d'amas stellaires. Paris, 1891.

Rev: Astron. Jour., 11: 128. 1892.

——. Sur une nébuleuse variable. Compt. Rend., 112: 471–4. 1891.

Burnham (S. W.) Measures of planetary nebulæ with the 36-inch equatorial of the Lick Observatory. Month. Not., 52: 31–46. 1891.

——. Observations of nebulæ with the 36-inch . . . Month Not., 52: 440–61. 1892.

Denning (W. F.) Variations in nebulæ. Obsry., 14: 196. 1891.

——. Supposed variable nebulæ. Astron. Nachr., 130: 231. 1892.

Dreyer (J. L. E.) Note on some apparently variable nebulæ. Month. Not., 52: 100–3. 1891.

Wolf (M.) Note on a nebula surrounding ζ Orionis discovered by photography. J. Brit. Astron. Assn., 1: 252,4. 297. 1891.

Nebulæ (Catalogues of).

Bigourdan (G.) Nébuleuses nouvelles découvertes à l'observatoire de Paris. Compt. Rend., 112: 647, 703, 848. 1891.

Swift (L.) Catalogue No. 10 of nebulæ discovered at the Warner Observatory. Astron. Nachr., 129: 361. 1892.

Nebulæ (Motions of) in the line of sight.

Keeler (J. E.) Motions of the nebulæ in the line of sight. Obsry., 14: 52. 1891.

Nebulæ (Spectra of).

Hale (G. E.) Researches on the magnesia fluting in connection with the spectra of the nebulæ. Sid. Mess., 10: 23–30. 1891.

Keeler (J. E.) [Chief line in the spectrum.] Sid. Mess., 10: 264–9. 1891.

——. Chief line in the spectrum of the nebulæ. Proc. Roy. Soc., 49: 399–403. 1891. *Also*, Reprint.

Nebular hypothesis.

Keeler (J. E.) [Lecture on] the nebular hypothesis. il. Astron. and Astrophys. 11: 567, 768. 1892.

Nebular hypothesis—Continued.

THOMSON (W.) Comment le soleil a commencé à bruler. il. L'Astron., 11: 361-7. 1892.

Neptune.

HOLDEN (E. S.) Historical note relating to the search for the planet Neptune in England in 1845-6. Pub. Astron. Soc. Pacific, 4: 21. 1892.

Normal equations.

HERZ (N.) Auflösung der Normalgleichungen. Astron. Nachr., 129: 353-6. 1892.

Nova Aurigæ, 1892.

CAMPBELL (W. W.) Spectrum of Nova Aurigae. il. Pub. Astron. Soc. Pacific, 4: 231-47. 1892.

——. Recent observations. Astron. and Astrophys., 11: 715-9. 1892.

——. Spectrum . . . in Feb. and Mar., 1892. il. Astron. and Astrophys., 11: 799-811. 1892.

——. [Observations Sept. 8 to Oct. 13, 1892.] Astron. and Astrophys., 11: 820. 1892.

——. [Motion in the line of sight.] Astron. and Astrophys., 11: 881. 1892.

CLERKE (A. M.) The new star in Auriga. Astron. and Astrophys., 11: 504-13. 1892. *From:* Contemp. Rev. Apr., 1892.

——. Nova Aurigæ and its suggestions. Obsry., 15: 286-9. 1892.

——. Nova Aurigæ. Obsry., 15: 334-9. 1892.

COPELAND (R.) [Discovery and spectrum.] Astron. and Astrophys., 11: 593-602. 1892.

CREW (H.) Visible spectrum of the new star in Auriga. Astron. and Astrophys., 11: 231-3. 1892.

ESPIN (T. E.) Spectroscopic observations and light curve . . . J. Brit. Astron. Assn., 2: 328-32. 1892.

HOLDEN (E. S.) The new star of 1892. il. Californian. Il. Mag., 1: 404-9. [Apr.] 1892.

HUGGINS (W.) Spectrum of Nova Aurigæ. il. Astron. and Astrophys., 11: 571-81. 1892.

HUGGINS (W.), LOCKYER (J. N.), *and others.* The new star in Auriga. Obsry., 15: 136-43. 1892.

PICKERING (E. C.) Nova Aurigæ. Astron. and Astrophys., 11: 417. 1892.

——. The new star in Auriga. il. Astron. and Astrophys., 11: 228-31. 1892.

SCHAEBERLE (J. M.) Theoretical photographic magnitudes. Astron. Jour., 12: 36-9. 1892.

SEELIGER (H.) Neuen Stern im Sternbilde Auriga. Astron. Nachr., 130: 393-406. 1892.

——. [Results of observations] on the new star in the constellation Auriga. Astron. and Astrophys., 11: 904-17. 1892.

SIDGREAVES (W.) Spectrum of Nova Aurigæ. Astron. and Astrophys., 11: 604-7. 1892.

——. Note on the revival of Nova Aurigæ. Astron. and Astrophys., 11: 882-4. 1892.

VOGEL (H. C.) Motion of Nova Aurigæ in the line of sight. Astron. and Astrophys., 11: 391-3. 1892.

YOUNG (C. A.) and REED (T.) Observations . . . at Princeton. Astron. and Astrophys., 11: 289-91. 1892.

Nova of 1006.

SCHÖNFELD (E.) Neuen Stern von 1006. Astron. Nachr., 127: 153. 1891.

Nutation.

FOLIE (F.) Formules correctes de la nutation initiale. Astron. Nach., 128: 6-12. 1891.

HERZ (N.) Zu dem Aufsatze des Herrn Folie. Astron. Nachr., 128: 47. 1891.

Object Glasses.

Cooke (T.) & Sons. Adjustment and testing of telescopic objectives. 6+49 p. il. 8vo. York, 1891.

Spitta (E. J.) Note on some photometric experiments connected with the application of the law of limiting apertures to small object-glasses. il. Month Not., 52: 48–51. 1891.

Observatories.

Gill (D.) Astronomer's work in a modern observatory. Obsry., 14: 335, 370, 408. 1891.

Jahresberichte der Sternwarte für 1890. Vrtljschr. d. astron. Gesellsch., 26: 83–169. 1891.

Jahresberichte der Sternwarte für 1891. Vrtljschr. d. astron. Gesellsch., 27: 72–166. 1892.

Newall (H. F.) Notes on visits to some American observatories. Obsry., 14: 152, 188, 221. 1891.

Pickering (W. H.) Astronomical possibilities at considerable altitudes. Astron. Nachr., 129: 97. 1892.

——. Astronomical possibilities at considerable altitudes. Obsry., 15: 283–6. 1892.

Proceedings of observatories [1890]. Month. Not., 51: 208–36. 1891.

——. Same, 1891; Month. Not., 52: 243–69. 1892.

Upton (W.) Ancient and modern observatories. Sid. Mess., 10: 481–9. 1891.

Optics.

Steinheil (A.) and Voit (E.) Handbuch der angewandten Optik. 1 Band. 314 p. 8vo. Leipzig, 1891.

Rev. by Crew (H.) Pub. Astron. Soc. Pacific. 4: 31. 1892.

Orbits.

Fabritius (W.) Leichte Methode der Bahnbestimmung mit Zugrundelegung des Princeps von Gibbs. Astron. Nachr., 128: 225–8. 1891.

——. Verhältniss des Dreiecks zum Sector der Kegelschnitte. Astron. Nachr., 129: 49. 1892.

——. Weitere Anwendungen des Gibbs'schen Princips. Astron. Nachr., 128: 321–8. 1891.

Radau (R.) Remarques relatives à la théorie des orbites. Bull. Astron., 9: 321–40. 1892.

Schultz (E.) Anwendung der Hamilton'schen partiellen Differentialgleichung bei der Bahnbestimmung eines von einem homogenen Sphäroid angezogenen Punktes. Astron. Nachr., 127: 265–90. 1891.

Searle (G. M.) Computation of places in eccentric ellipses and hyperbolas. Astron. Jour. 11: 89–92. 1892.

Vogel (R.) Methode für Bahnbestimmung. Astron. Nachr., 129: 37–44. 1892.

Parallax (Solar).

Auwers (A.) Sonnenparallaxe nach den Heliometerbeobachtungen der deutschen Venus-Expeditionen von 1874 und 1882. Astron. Nachr., 128: 329–38. 1891.

Hall (A.) Solar parallax and the mass of the earth. Astron. Jour. 11: 20. 1891.

Harkness (W.) Solar parallax and its related constants. 169 p. 4to. Washington. 1891.

Washington observations, 1885 app. 3.

Stone (E. J.) Note on some values of the sun's mean horizontal parallax which have been deduced from the transit of Venus observations made in 1882. Month. Not., 52: 124. 1892.

Parallax (Stellar).

Boss (L.) Bestimmung von Parallaxen durch Registrir-Beobachtungen am Meridiankreise von Dr. J. C. Kapteyn. Pub. Astron. Soc. Pacific, 3: 346-53. 1891.

Hall (A.) [Method of reduction.] Astron. Jour., 11: 7. 1891.

Kapteyn (J. C.) Bestimmung von Parallaxen durch Registrir-Beobachtungen am Meridiankreise. 128 p. 4to. Haag. 1891.

Rev. Astron. Jour., 11: 8. 1891.

Kleiber (J.) Mittlere Entfernung derjenigen Sterne deren eigene Bewegung im Visionsradius bekannt ist. Astron. Nachr., 127: 209-12. 1891.

Leavenworth (F. P.) Parallax of δ Herculis from observations made by Dembowski. Astron. Jour., 11: 169-72. 1892.

——. Proper motion and parallax of δ Equulei. Astron. Jour. 12: 41. 1892.

Pritchard (C.) Parallax of β Aurigæ. Month. Not., 51: 310. 1891.

——. Parallax ot β Aurigæ. Astron. Nachr., 127: 201-8. 1891.

Schur (W.) Bestimmung der Parallaxe von β Orionis. Astron. Nachr. 127: 147. 1891.

Paris Observatory.

Bassot (—.) and Defforges (—.) Détermination récente de la longitude Paris-Greenwich. Month. Not. 51: 407-13. 1891.

Deslandres (H.) Transformation du grand télescope . . . pour l' étude des vitesses radiales des astrès. Résultats obtenus. Compt. Rend., 115: 783-6. 1892.

Rapport annuel . . . 1890. 32 p. 4to. Paris, 1891.

Rapport annuel . . . 1891. 39 p. 4to. Paris, 1892.

Turner (H. H.) Note on the recent determination of the longitude of Paris. Month. Not., 51: 155-63. 1891.

——. Recent determination of the longitude Paris-Greenwich: reply to Col. Bassot and Commandant Defforges. Month. Not., 51: 413-9. 1891.

Pendulum.

Mendenhall (T. C.) Use of a free pendulum as a time standard. Am. j. Sc., 143: 85-90. 1892.

von Rebeur-Paschwitz (E.) Horizontalpendel-Beobachtungen in Wilhelmshaven, Potsdam, und Puerto Orotava auf Teneriffa. Astron. Nachr., 130: 193-216. 1892.

Personal equation.

Christie (W. H. M.) Preliminary note on the change of personal equation with stellar magnitude in transits observed with the transit circle . . . Greenwich. Month. Not. 51: 455-8. 1891.

Gonnessiat (F.) Quelques remarques à propos des recherches expérimentales sur l'équation personnelle. Bull. Astron., 9: 374-9. 1892.

——. Sur l'équation personnelle dans les observations de passages. Compt. Rend., 112: 207-9. 1891.

Stroobant (P.) Recherches expérimentales sur l'équation personnelle dans les observations de passages. il. Bull. Astron, 9: 146-60. 1892. *See, also.* Compt. Rend., 113: 457-60. 1891.

——. Nouvelles recherches expérimentales sur l'équation personnelle dans les observations de passage. Compt. Rend., 115: 1246-50. 1892.

Perturbations.

de Ball (L.) Bemerkung über die Differential Quotienten der Störungsfunction. Astron. Nachr., 128: 107. 1891.

——. Bemerkung über die Coefficienten einer Reihe der Störungstheorie. Astron. Nachr., 128: 339-42. 1891.

Láska (W.) Berechnung der absoluten Störungen. 7 p. 8vo. Prag, 1891.

Masal (H.) Formeln und Tafeln zur Berechnung der absoluten Störungen der Planeten. 31 p. 4to. Stockholm [1891].

Perturbations.—Continued.

TISSERAND (F.) Équation différentielle relative au calcul des perturbations. Compt. Rend., 114: 441-4. 1892.

WEILER (A.) Allegemeinen Störungen des inneren Planeten. Astron. Nachr., 128: 49-108. 1891.

——. Allgemeinen Störungen des äusseren Planeten. Astron. Nachr., 128: 257-92. 1891.

WELLMANN (V.) Tafeln zur Berechnung der Störungsfunctionen. der kleinen Planeten. Astron. Nachr., 127: 257-66. 1891.

Photochronograph.

HAGEN (J. G.) Photochronograph angewandt auf Doppelsternmessungen. Astron. nachr., 128: 177-86. 1891.

[HAGEN (J. G.) and FARGIS (G. A.)] The photo-chronograph and its application to star transits. 36 p. il. 4to. Washington, 1891.

Photographic Congress, Paris.

BULLETIN du comité international permanent pour l'exécution photographique de la carte du ciel. Tome 2. 1. fascicule, 124 p. 4to. Paris, 1892.

[PROGRESS of] the astro-photographic chart. Obsry. 14: 184-8. 1891.

RÉUNION du comité international permanent pour l'exécution de la carte photograhphique du ciel à l'observatoire de Paris en 1891. 135 p. 4to. Paris, 1891.

Photography (Astronomical).

BARNARD (E. E.) Photographing with a non-photographic telescope. Sid. Mess., 19: 331-5. 1891.

——. Simple and rapid method of detecting changes on celestial photographs due to motion or variability of the celestial bodies. Astron. Nachr., 130: 77. 1892.

BURNHAM (S. W.) The camera for celestial photography. Sid. Mess., 10: 325-8. 1891.

HARKNESS (W.) Astronomical photography with commercial lenses. Astron. and Astrophys, 11: 641-8. 1892.

SCHAEBERLE (J. M.) Preliminary note on terrestrial atmospheric absorption of the photographic rays of light. Astron. Jour., 12: 115. 1892.

Photography (Stellar).

CHARLIER (C. V. L.) Anwendung der Sternphotographie zu Helligkeitsmessung der Sterne. 29 p. 4to. Leipzig, 1889. Pub. d. Astron. Gesellsch. 19.

CHRISTIE (W. H. M.) Relation between diameter of image, duration of exposure, and brightness of objects in photographs of stars taken at . . . Greenwich. Month. Not., 52: 125-46. 1892.

——. Notes on the preparations for the work of the astro-photographic chart at . . . Greenwich. Month. Not. 51: 278-86. 1891.

DUNÉR (N. C.) Photographische Versuchs-Aufnahmen von Sternen. Astron. Nachr., 127: 365. 1891.

HARZER (P.) Ueber Sternphotographien. Astron. Nachr., 130: 113-20. 1892.

JACOBY (H.) Reduction of astronomical photographic measures. Astron. Jour., 10: 129-31. 1891.

LOEWY (M.) Détermination des coordonnées équatoriales des centres des clichés constituant la carte du ciel. Compt. Rend., 112: 1393-9. 1891.

PRITCHARD (C.) Further experience regarding the magnitude of stars as obtained by photography in the Oxford University Observatory. Month. Not., 51: 430-5. 1891.

REES (J. K.) Catalogue of Rutherfurd's photographic plates of the sun, the moon and the stars. 8 p. 8vo. [New York. 1891.]
Repr. from: Ann. N. Y. Acad. Sc., 6.

Photography (Stellar)—Continued.

——. Preliminary notice of the reduction of Rutherfurd's star-plates. Obsry., 15: 49–55. 1892.

WELLMAN (V.) Hülfsmittel zur Erkennung von Bewegungserscheinungen auf Photographien des Sternhimmels. Astron. Nachr., 131: 31. 1892.

WOLF (M.) Photographische Messung der Sternhelligkeiten im Sternhaufen. G. C., 4410. Astron. Nachr., 126: 297–310. 1891.

Photometer.

WILSON (W. E.) New photographic photometer for determining star magnitudes. Month. Not., 52: 153–5. 1891.

Photometry.

ABNEY (W. de W.) Estimation of star magnitudes by extinction with the wedge. Month. Not., 52: 426–9. 1892.

GORE (J. E.) Intensity of the images of stars as affected by wire-gauze screens placed before object glasses. Obsry. 15: 106–8. 1892.

SCHEINER (J.) Photographisch-photometrische Untersuchungen. Astron. Nachr., 128: 113–22. 1891.

Planets.

FLAMMARION (C.) Idée d'une communication entre les mondes: à propos d'un testament astronomique. L'Astron., 10: 282–7. 1891.

Planets (Figure of.)

CALLANDREAU (O.) Mémoire sur la theorie de la figure des planètes. 84 p. 4to. [n. p. n. d.]

Repr. from: Ann. de l'Obs. de Paris Mém. 19. 1891. [?]

Pleiades.

BARNARD (E. E.) Nebulosities of the Pleiades, and on a new Merope nebula. il. Astron. Nachr., 126: 293. 1891.

JACOBY (H.) The Rutherfurd photographic measures of the group of the Pleiades. Ann. N. Y. Acad. Sc., 6: 237–330. 1892. *Also* Reprint.

Rev. by Scheiner (J). Vrtljschr. d. Astron. Gesellsch., 27: 206–13. 1892.

PRITCHARD (C.) Newly discovered Merope nebula. Astron. Nachr., 126: 397. 1891.

ROGERS (W. A.) Division errors of the graduated scale used in the Rutherfurd photographic measures of the Pleiades. Astron. Jour., 12: 129–33. 1892.

Pogson (Norman Robert). [1829–'91.]

For *Biography, see* Month. Not., 52: 235–8. 1892.

Potsdam Observatory.

LEUSCHNER (A. O.) [Description of buildings and instruments.] Pub. Astron. Soc. Pacific, 4: 40–5. 1892.

Precession.

KREUTZ (H.) Hülfsgrössen zur Berechnung der Praecession nach Struve für mehrere öfters vorkommende Epochen. Astron. Nachr., 128: 250. 1891.

Precession (Constant of).

RISTENPART (F.) Untersuchungen über die Constante der Praecession und die Bewegung der Sonne im Fixsternsysteme. Veröffentl. d. grossherzog. Strnwrt Karlsruhe, 4: 197–288. 1892.

Procyon.

STRUVE (L.) Unregelmässige Eigenbewegung von Procyon nach. O. Struve's Mikrometermessungen. Astron. Nachr., 130: 177–86. 1892.

Prominences (Solar).

EVERSHED (J.) jr. Distribution of the solar prominences of 1891. J. Brit. Astron. Assn., 2:174–7. 1892.

FÉNYI (J.) Eine am 3 Oct., 1892, beobachtete grosse Protuberanz. il. Astron. Nachr., 131: 213. 1892.

Prominences (Solar)—Continued.

Fizeau (H. L.) Influence que l'aberration de la lumière peut exercer sur les observations . . . Compt. Rend. 113: 353-6, 1891.

Hale (G. E.) Photography and the invisible solar prominences. Sid. Mess., 10: 257-64. 1891.

——. Results obtained in photographing solar prominences and their spectra. Astron. Nachr., 128: 109. 1891.

——. Solar-prominence photography. Astron. Nachr., 127: 211-4. 1891.

——. Ultra-violet spectrum of the solar prominences. Astron. and Astrophys., 11: 602. 1892.

——. Ultra-violet spectrum of the solar prominences. Am. J. Sc., 142: 459-67. 1891.

——. Photographic investigation of solar prominences and their spectra. il Am. J. Sc., 142: 160-6. 1891.

Trouvelot (E. L.) Protubérances solaires remarquables. il. L'Astron., 11: 249-52. 1892.

Proper motions.

Boss (L.) Proper motions of 27 southern stars. Astron. Jour., 11: 105-7. 1892.

Bossert (J.) Détermination des mouvements propres des étoiles du catalogue de l'observatoire de Paris. Bull. Astron., 8: 369-76. 1891.

——. Détermination des mouvements propres de quelques étoiles. Bull. Astron., 9: 216-9. 1892.

Burnham (S. W.) Proper motion of Σ 1603. Astron. and Astrophys., 11: 549. 1892.

——. Proper motion of the components of 61 Cygni. Sid. Mess., 10: 1-5. 1891

——. Proper motion of Σ 1604. Astron. and Astrophys., 11: 870-2. 1892.

——. Proper motion of H 1968. Month. Not., 51: 108-10. 1891.

——. Proper motion of Σ 547. Obsry., 14: 56. 1891.

Doolittle (C. L.) [List of] proper-motion stars. Astron. Jour., 12: 103. 1892.

Dreyer (J. L. E.) Proper motions of 20 southern stars. Month. Not., 51: 466-74. 1891.

Monck (W. H. S.) [Connection between proper motions and spectra.] Astron. Jour., 12: 147. 1892.

——. Proper motion of the stars. Astron. and Astrophys., 11: 874-8. 1892.

Porter (J. G.) Catalogue of stars with proper motion of half a second and upwards. Astron. Jour., 12: 25-30. 1892.

——. Catalogue of proper-motion stars. 254 p. 4to. Cincinnati, 1892. Publns Cincin. Obsry., 12.

Thackeray (W. G.) Approximate proper motions of some Groombridge stars Month. Not., 51: 397. 1891.

Refraction.

Chandler (S. C.) Refraction correction of photographic measures. Astron Jour., 10: 175. 1891.

——. Rigorous computation of differential refraction. Astron. Jour., 10: 181 1891.

——. Device for eliminating refraction in micrometric or photographic measures. Astron. Jour., 12: 51. 1892.

Hausdorff (F.) Zur Theorie der astronomischen Strahlenbrechung 86 p. 8vo. Leipzig, 1892.

Jacoby (H.) Correction of photographic measures for refraction. Astron. Jour., 10: 163, 183, 191. 1891.

Nyrén (M.) Refraction im Beobachtungsraume. Astron. Nachr., 131: 291. 1892.

Radau (R.) Essai sur les réfractions astronomiques. 80 p. 4to, Paris, 1889.
Rev. by Bauschinger (J.) Vrtljschr. d. Astron. Gesellsch., 27: 12-20. 1892.

Refraction—Continued.

RAMBAUT (A. A.) Corrections for refraction to measures of stellar photographs. Astron. Nachr., 131: 65–74. 1892.

SEELIGER (H.) Notiz über die Strahlenbrechung in der Atmosphäre. Sitzungsb. d. K. Bayer. Akad. d. Wessensch. 21: 239–46, 1891.

Rev. by Safarik (A.) Vrtljschr d. Astron. Gesellsch., 27: 238–43. 1892.

——. Extinction des lichtes in der Atmosphäre. Sitzungsb. Math.-Phys. Cl. d. k. bayer. akad. d. Wissensch., 21: 239, 247. 1891.

Rev. by Safarik (A.) Vrtljschr. d. Astron. Gesellsch., 27: 238-43. 1892.

Rutherfurd (Lewis Morris). [1816–'92.]

REES (J. K.) [Biographical sketch.] Astron. and Astrophys., 11: 689–97. 1892.

For *Portrait, see Ibid.*

For *Biography see also* Astron. Jour., 12: 32. 1892.

Saturn.

BARNARD (E. E.) Transparency of the crape ring. . . . Astron. and Astrophys., 11: 119–23. 1892.

DENNING (W. F.) [Drawings of] Saturn. il. Obsry., 14: 366-70. 1891.

FLAMMARION (C.) Disparition apparente des anneaux de Saturne. il. L'Astron., 10: 121–39. 1891.

FREEMAN (A.) Illumination of Saturn's rings during sunrise; and on recent observations of their reappearance. Month. Not., 52: 491-9. 1892.

HOLDEN (E. S.) Observations and drawings of Saturn, 1879-1889. il. Pub. Astron. Soc. Pacific, 3: 11–19. 1891.

PICKERING (W. H.) The planet Saturn and its satellites. Astron. and Astrophys., 11: 649–52. 1892.

TROUVELOT (E. L.) Phenomena observed . . . . in 1877–'78. Sid. Mess., 10: 74, 119, 171. 1891.

WILLIAMS (A. S.) Recently discovered spots on Saturn. il. Astron. Nachr., 128: 33–8. 1891.

Saturn (Satellites of).

EICHELBERGER (W. S.) Orbit of Hyperion. Astron. Jour., 11: 145. 1892.

HALL (A.) Orbit of Iapetus. Astron. Jour. 11: 97–102. 1892.

SAFARIK (A.) Durchmesser des Saturnsatelliten Titan. Astron. Nachr., 127: 365. 1891.

Sayre Observatory.

DOOLITTLE (C. L.) Latitude. Astron. Nachr., 128: 213–8. 1891.

Scheiner (Christoph).

VON BRAUNMÜHL (A.) Christoph Scheiner als Mathematiker, Physiker und Astronom., 6 + 92 p. 8vo. Bamberg, 1891.

Rev. by Günther (S.) Vrtljschr. d. Astron. Gesellsch. 26: 229–35. 1891.

Schönfeld (Eduard). [1828–'91.]

KRUEGER (A.) Todes-Anzeige. Vrtljschr. d. Astron. Gesellsch., 26: 172–85. *Also,* Astron. Nachr., 127: 151. 1891. *Also, transl.*: Pub. Astron Soc. Pacific. 3: 255. 1891. *Also, abstr.*: Month. Not., 52: 239–42. 1892.

For *Biography, see also* Astron. Jour., 11: 16. 1891. For *Portrait, see* Vrtljschr. d. Astron. Gesellsch., 26.

Schultz (Per Magnus Herman). [1823–'90.]

For *Biography* see Vrtljschr. d. Astron. Gesellsch. 26: 3. 1891.

For *Portrait* see Ibid.

Seydler (August.) [1849–'91.]

LÁSKA (W.) Todes-Anzeige. Astron. Nachr., 128: 15. 1891.

Sirius.

AUWERS (A.) Beiträge zur Kenntniss des Sirius-Systems. Astron. Nachr., 129: 185–232. 1892.

See, also, L'Astron., 11: 410.1.

Sirius—Continued.

BURNHAM (S. W.) [Observations and orbit]. il. Month. Not., 51: 378–88. 1891.

GORE (J. E.) [Inherent light of] the companion of Sirius. J. Brit. Astron. Assn., 1: 318. 1891.

HOWARD (C. P.) Orbit of the companion of Sirius. Astron. Jour., 10: 149–50. 1891.

SEE (T. J. J.) History of the color of Sirius. Astron. and Astrophys., 11: 269–74; 372–86; 550–2. 1892.

Sky Glows.

FOERSTER (W.) and JESSE (O.) Aufforderung zu Beobachtungen der leuchtenden Nachtwolken. Astron. Nachr., 130: 425–30. 1892.

——. Request for observations of night clouds. Astron. and Astrophys., 11: 859–63. 1892.

Smithsonian Astrophysical Observatory.

[DESCRIPTION of the building and instruments.] Sid. Mess., 10: 271–3. 1891.

[INSTRUMENTS, and work proposed.] Obsry., 14: 224. 1891.

LANGLEY (S. P.) [Established as a department of the Smithsonian Institution.] Astron. Nachr., 127: 319. 1891.

Solar System.

PLAN du système solaire. il. L'Astron., 11: 301. 1892.

Solar System (Motion of).

MONCK (W. H. S.) The sun's motion in space. Pub. Astron. Soc. Pacific, 4: 70–7. 1892.

PORTER (J. G.) Motion of the solar system. Astron. and Astrophys., 11: 764. 1892. *Also,* Astron. Jour., 12: 91. 1892.

RISTENPART (F.) Untersuchungen über die Constante der Praecession und die Bewegung der Sonne im Fixsternsysteme. Veröffentl. d. grosshezogl. Strnwrt. Karlsruhe., 4: 197–288. 1892.

Spectra (Stellar).

ESPIN (T. E.) [List of] stars with remarkable spectra. Astron. Nachr., 126: 361–6. 1891.

——. List of stars with remarkable spectra. Astron. Nachr., 129: 297–302. 1892.

FLEMING (M.) Stars having peculiar spectra. Sid. Mess., 10: 7. 1891.

HUGGINS (W.) and HUGGINS (*Mrs.* W.) Wolf and Rayet's bright-line stars in Cygnus. Sid. Mess., 10: 49–65. 1891. *See, also,* Obsry., 14: 45. 1891.

MONCK (W. H. S.) Spectra and proper motions of stars. J. Brit. Astron. Assn., 2: 440–3. 1892.

——. Spectra and proper motions of stars. Astron. and Astrophys., 11: 389–90. 1892.

PICKERING (E. C.) Distribution of energy in stellar spectra. Astron. Nachr., 128: 377. 1891.

——. Fifth type of stellar spectra. Astron. Nachr., 127: 1. 1891.

——. Spectrum of β Lyrae. Astron. Nachr., 128: 39. 1891.

——. The objective prism. il. Astron. and Astrophys., 11: 199–203. 1892.

Spectroheliograph.

HALE (G. E.) Solar photography at the Kenwood Astrophysical Observatory. il. Astron. and Astrophys., 11: 407–17. 1892.

Spectroscope.

CAMPBELL (W. W.) Reduction of spectroscopic observations of motions in the line of sight. Astron. and Astrophys., 11: 319–25. 1892.

Spectroscope—Continued.

Keeler (J. E.) Elementary principles governing the efficiency of spectroscopes for astronomical purposes. Sid. Mess., 10: 433-53. 1891.

——. The modern spectroscope 2: the star spectroscope of the Lick Observatory. il. Astron. and Astrophys., 11: 140-4. 1892. *Also*, Reprint.

Newall (H. F.) Diagram useful as a guide in adjusting a diffraction grating spectroscope. il. Month Not., 52: 510-12. 1892.

Young (C. A.) New spectroscope of the Halsted Observatory. il. Astron and Astrophys., 11: 292-6 1892.

Spectroscopy.

Hale (G. E.) Pending problems in spectroscopy. Sid. Mess., 10: 89-91. 1891.

Spectrum analysis.

Huggins (W.) On spectroscopic astronomy. 35 p. 8vo. London, 1891. *Repr. from*: Brit. Assn. Adv. Sc. 61 (meeting): 3-37. 1891.

Scheiner (J.) Die Spectralanalyse der Gestirne. 8+474 p. 8vo. Leipzig, 1890.

Rev. by Ebert (H.) Vrtljschr. d. Astron. Gesellsch., 27: 28-36. 1892.

——. Berichtigungen zu "Die Spectralanalyse der Gestirne." Astron. Nachr., 129: 157. 1892.

Spectrum (Solar).

Abney (W. de W.) Limit of visibility of the different rays of the spectrum. *Also* Astron. and Astrophys., 11: 296-305. 1892.

Repr. from: Proc. Roy. Soc. 49: 509-18. 1891.

Cortie (A. L.) Some recent studies on the solar spectrum. Astron. and Astrophys., 11: 393-407. 1892.

Star-Catalogues.

Auwers (A.) Supplément à l'histoire céleste de Lalande: Catalogue de 3950 etoiles ... par M. J. Bossert. Vrtljschr. d. Astron. Gesellsch, 11: 255-70. 1892.

Berichte über die Beobachtung der Sterne bis zur neunten Grösse am nördlichen Himmel. Vrtljschr. d. Astron. Gesellsch., 26: 284-301. 1891.

Berichte über die Beobachtung der Sterne bis zur neunten Grösse zwischenn—2° und—23°. Vrtljschr. d. Astron. Gesellsch., 26: 302-5. 1891.

Catalog der Astronomischen Gesellschaft. Erste Abth., 5. Stück Zone+50° bis +55°. Catalogue of 8,627 stars ... from observations ... at the Astronomical Observatory of Harvard College ... 1870 to 1884 by W. A. Rogers. 39+176 p. 4to. Leipzig, 1892.

Catalogue de l'observatoire de Paris. Tome 2. Paris, 1891.

Downing (A. M. W.) Apparent places of close polar stars. Month Not., 52: 378-85. 1892.

Eastman (J. R.) The neglected field of fundamental astronomy. Proc. Am. Assn. Adv. Sc., 41: 17-32. 1892. *Also* Reprint.

Hilfiker (J.) Catalogue d'étoiles lunaires. 58 p. 4to. Neuchatel, 1891.

Romberg (H.) Catalog von 5634 Sternen für die Epoche 1875.0 aus den Beobachtungen am Pulkowaer Meridiankreise... 1874-1880. 22+142 p. 4to. St. Petersb., 1891. (Sup. III aux. Obsns. de Poulkova.)

Schur (W.) Stern-Catalog enthaltend 6900 Sternörter für 1860.0. Nach den von Klinkerfues in den Jahren, 1858-63 angestellten Zonenbeobachtungen abgeleitet, 28+77 p., 1 pl. 4to. Göttingen, 1892. (Astron. Mitth. Sternw.)

Star-Charts.

Weiss (E.) Bilder-Atlas der Sternenwelt. 41 pl. fol. Esslingen, 1891.

Star-Clusters.

Hahn (R.) Mikrometrische Vermessung des Sternhaufens Σ 762 ... 144 p., 1 pl. 8vo. Leiprig, 1891.

Repr. from: K. Säch. Gesellsch. d. Wissensch. v. 17, No. 3. 1891. *Rev.* Astron. Jour., 11: 80. 1891.

Star-Clusters.—Continued.

Oertel (K.) Neue Beobachtung und Ausmessung des Sternhaufens. 38 *h.* Persei. 92 p., 2 pl. 4to. München, 1891.

Pihl (O. A. L.) Stellar cluster χ Persei micometrically surveyed. 107 p., 2 pl. 4to. Christinia, 1891.

Star-Places (Reduction of).

Folie (F.) Formulae of reduction to apparent places of close polar stars. Month Not., 52: 551–6. 1892.

Stars.

Lockyer (J. N.) Causes which produce the phenomena of new stars. 52 p. il. 8vo. London, 1891.

Whitmore (E. B.) [Disposition of certain stars in space.] 20 p., 2 pl. 8vo. Rochester, 1892.

Stars (Motion of) in the line of sight.

Maunder (E. W.) Potsdam observations of motion in the line of sight. Obsry. 15: 393–8. 1892.

Spectroscopic results . . . at . . . Greenwich . . . 1890. Month Not., 51: 136. 1891.

Vogel (H. C.) Iron spectrum as a comparison spectrum in spectrographic determinations of stellar motion in the line of sight. Astron. and Astrophys., 11: 151–7. 1892. *Transl. from:* Sitzungsb. d. Berl. Akad. Wissensch. 28: 533 (4 June, 1891.)

——. Untersuchungen über die Eigenbewegungen der Sterne im Visionsradius auf spectrographischem Wege. Potsdam, 1892. (Pub. d. Astrophys., Obs. zu Potsdam, Bd. 7, Th. 1 (No. 25). 4+166 p. 4to.

Rev. by Ebert (H.) Vrtljschr. d. Astron. Gesellsch., 27: 302–7. 1892.

——. Spectroscopic method of determining the velocity of stars in the line of sight. Month Not., 52: 87–96. 1891. *Also* Astron. and Astrophys., 11: 203–12. 1892.

——. List . . . of 51 stars. Month. Not., 52: 541–3. 1892.

——. Ueber β Aurigae. Astron. Nachr., 127: 251. 1891.

Strassburg Observatory.

Holden (E. S.) [Description of the building and instruments.] il. Pub. Astron. Soc. Pacific., 3: 279–82. 1891.

Sun.

Brown (E.) Hints to beginners in solar observation. Pub. Astron. Soc. Pacific, 3: 172–5. 1891.

Deslandres (H.) New researches on the solar atmosphere. Astron. and Astrophys., 11: 314–5. 1892. *See, also,* Compt. Rend. 114: 276. 1892.

Ferrel (W.) Measures of the intensity of solar radiation. Am. Jour. Sc., 141: 378–86. 1891.

Frost (E. B.) Observations on the thermal absorption in the solar atmosphere. Astron. Nachr., 130: 129–46. 1892.

——. Observations on the thermal absorption in the solar atmosphere made at Potsdam. Astron. and Astrophys., 11: 720–37. 1892.

Hale (G. E.) Condition of the sun's surface in June and July, 1892, as compared with the record of terrestrial magnetism. Astron. and Astrophys. 11: 917–25. 1892.

——. Photographs of solar phenomena obtained with the spectro-heliograph of the Kenwood Astrophysical Observatory. il. Astron. and Astrophys., 11: 603. 1892.

——. A remarkable solar disturbance, 1892, July 15. Astron and Astrophys., 11: 611–3. 1892.

——. Some results and conclusions derived from a photographic study of the sun. Astron. and Astrophys., 11: 811–5. 1892.

Sun—Continued.

——. Recherches sur l'atmosphère solaire. Compt. Rend. 114: 1406. 1892.

Harzer (P.) Rotationsbewegung der Sonne. Astron. Nachr., 127: 17–34. 1891.

Kedzie (J. H.) Speculations, solar heat, gravitation, and sun spots. 2d ed. [5+75 p.] 8vo. Chicago, 1891.

Maunder (E. W.) Solar activity in 1890. J. Brit. Astron. Assn., 1: 321–5. 1891.

Sidgreaves (W.) Solar disturbances of July, 1892, and the accompanying magnetic storms. Astron. and Astrophys., 11: 817–9. 1892.

Trouvelot (E. L.) Phénomène lumineux extraordinaire observé sur le soleil. Compt. Rend. 112: 1419-21. 1891. *Also*, Reprint.

Wilsing (J.) Rotationsgesetz der Sonne und über die Periodicität der Sonnenflecke. Astron. Nachr., 127: 233–52. 1891.

Wolfer (A.) Comptes rendus des travaux de . . . R. Wolf dans la domaine de la physique solaire. Arch. d. Sc. Phys. et. Nat. Geneva, Dec., 1891.
Rev. Astron. Jour., 11: 120. 1892.

Sun-dials.

Guillaume (C. E.) Cadrans solaires portatifs. il. L'Astron., 11: 383–9. 1892.

Sun (Diameter of).

Auwers (A.) Sonnendurchmesser und der Venusdurchmesser nach den Beobachtungen an den Heliometern der deutschen Venus-Expeditionen. Astron. Nachr., 128: 361–76. 1891.

Sun (Rotation of).

Dunér (N. C.) Recherches sur la rotation du soleil. 78 p. 4to. Upsal, 1891.
Rev. by Scheiner (J.) Vrtljschr. d. Astron. Gesellsch., 27: 36–51. 1892.

Sun spots.

Brown (E.) Note on the recent large groups of sun spots. il. J. Brit. Astron. Assn., 2: 210. 1892.

[Christie (W. H. M.)] On the large sun spot of 1892, Feb. 5-18, and the associated magnetic disturbance. Month. Not., 52: 354–7. 1892.

Cortie (A. L.) Large sun-spot group of Aug. 28–Oct. 4, 1891. Obsry., 14: 363–6. 1891.

——. Spectra of sun spots between B and D. J. Brit. Astron. Assn., 1: 175–84. 1891.

——. Notes on the spectra . . . Astron. and Astrophys., 11: 587–93

Crew (H.) Spectrum of the large sun-spot group of February, 1892. il. Astron. and Astrophys., 11: 308–10. 1892.

Fenyi (J.) Phenomena observed on the great spot-group of February, 1892. il. Astron. and Astrophys., 11: 430–3. 1892.

Hale (G. E.) Spectroscopic observations of the great sun-spot group of February, 1892. il. Astron. and Astrophys., 11: 310–4. 1892.

Landerer (J. J.) Mesure des coordonnées héliographiques des taches solaires. il. L'Astron, 10: 231–5. 1891.

Maunder (E. W.) Earlier appearances of the great spot-group of February, 1892. J. Brit. Astron. Assn. 2: 386–9. 1892.

——. Note on the history of the great sun spot of 1892, February. Month. Not., 52: 481–93. 1892.

Perkins (T.) Modified method of using Thomson's disks. il. J. Brit. Astron. Assn., 1: 492–5. 1891.

Schmoll (A.) Dernier minimum des taches solaires. L'Astron., 10: 383–91. 409. 1891.

Trouvelot (E. L.) Chute d'une protubérance solaire dans l'ouverture d'une tache. L'Astron., 10: 407. 1891. *Also:* Compt. Rend., 113: 437. 1891.

——. Fall of a solar prominence into the opening of a spot. Astron. and Astrophys., 11: 124. 1892.

Swathmore College Observatory.

Cunningham (S. J.) [Description of the observatory and instruments.] il. Pub. Astron. Soc. Pacific, 3: 21. 1891.

Tables.

Smithsonian meteorological tables. (Based on Guyot's meteorological and physical tables.) City of Washington, published by the Smithsonian Institution, 1893. 8vo. 59+262 pp.

From Smithsonian Miscellaneous Collections, Vol. 35 (No. 844.)

Wislecenus (W. F.) Tafeln sur Bestimmung der jährlichen Auf-und Unter-Gänge der Gestirne. 55 p. 4. Leipsig, 1892. Pub. Astron. Gesellsch., 20.

Telegrams.

English center for the distribution of astromical telegrams. Month. Not., 52: 406-8. 1892.

Telescope.

Bigelow (F. H.) Simple mounting for a large telescope in the field during eclipse observations. il. Astron. and Astrophys., 11: 257-68. 1892.

Common (A. A.) Two large telescopes. Obsry., 15: 389, 437. 1892.

Gruey (L. J.) Lunette horizonto-zenithale. Bull. Astron., 8: 5-10. 1891.

Hastings (C. S.) History of the telescope. Sid. Mess., 10: 335-54. 1891.

Knight (W. H.) Some telescopes in the United States. Sid. Mess., 10: 393-9. 1891.

Maunder (E. W.) Adjustment of a small equatorial. il. J. Brit. Astron. Assn., 2: 219-22. 1892.

Michelson (A. A.) Application of interference methods to astronomical measurements. il. Mem. Natl. Acad. Sc., 5: 579-90. (v. 5, 5 mem.) 1891.

Vallance (P.) Form of alt-azimuth mounting for telescopes. il. J. Brit. Astron. Assn., 2: 335-41. 1892.

Telescopes (Reflecting).

Calver (G.) Notes on the reflecting telescope. J. Brit. Astron: Assn., 2. 446-8. 1892.

Common (A. A.) Best form of mounting for a large reflector. Month. Not., 53: 19-22. 1892.

Holmes (E.) Notes upon reflecting telescopes. J. Brit. Astron. Assn., 2: 269-72. 1892.

Jones (G. S.) Alt-azimuth mounting for a small reflecting telscope. il. Sid. Mess., 10: 506. 1891.

Three Bodies (Problem of).

Callandreau (O.) Quelques applications des théories concernant les solutions particulières périodiques. . . . Bull. Astron., 8: 49-67. 1891.

——. Cas particulier du problème des trois corps. Bull. Astron., 9: 113-18. 1892.

Coculesco (—) Stabilité du mouvement dans un cas particulier du problème . . . Compt. Rend. 114: 1339-41. 1891.

Poincaré (H.) Problème des trois corps. Bull. Astron., 8: 12-24. 1891.

——. Application de la méthode de M. Lindstedt . . . Compt. Rend. 114: 1305-9. 1892.

Weiler (A.) Arbeit des Herrn Poincaré das Problem der drei Körper betreffend. Astron. Nachr., 127: 359. 1891.

Tides.

Tennant (J. F.) Address . . . on presenting the gold medal to Prof. G. H. Darwin. Month. Not., 52: 316-33. 1892.

Time (Determination of).

Beck (A.) Anwendung eines Objectivprismas zur Zeit und Polhöhenbestimmung. Astron. Nachr., 130: 81-96. 1892.

Time (Determination of)—Continued.

Comstock (G. C.) Efficiency of a small instrument. Sid. Mess., 10: 406-9. 1891.

Hedrick (J. T.) Probable error of the clock correction when both the clock rate and the instrumental constants are found by a least squares solution of a single night's observations. Month. Not., 53: 22-7. 1892.

Time (Universal).

Wolf (C.) Temps local et l'heure universelle. L'Astron., 11: 49-56. 1892.

Tisserand (Félix).

For *Biography see* L'Astron., 11: 344. 1892.
For *Portrait see ibid.*, 345.

Transit Instrument.

Herz (N.) Theorie eines mit einem Verticalkreise versehenen Passage-Instrumentes im ersten Verticale. 18 p. 4to. Wien, 1891.

Transit Observations.

Becker (E.) Versuche von Durchgangs Beobachtungen nach dem neuen Repsoldschen Verfahren. Astron. Nachr., 127: 185-90. 1891.

Jacoby (H.) Reduction of transit observations by the method of least squares. Month. Not., 52: 114-7. 1891.

Safford (T. H.) Observation of north polar stars in the vertical of Polaris. Astron. Nachr., 128: 379-82. 1891.

Trans-Neptunian Planet.

Roberts (I.) Photographic search for a planet beyond the orbit of Neptune. Month. Not., 52: 501. 1892.

Unites States Naval Observatory.

Bill defining the positions and salaries of assistant astronomers. 52 Cong., 1 sess. S. 824. Dec. 14, 1891.

[Bill to provide a more perfect organization.] 52 Cong., 1 sess. S. 1733. 1892.

Boss (L.) An irrepressible conflict. Sid. Mess., 10: 161-8. 1891.

——. Proposed reform in the management of the new Naval Observatory. A statement in respect to the U. S. Naval Observatory and its organization. 68 p. 8vo. Albany, 1891.

Change of management required for the United States Naval Observatory. 15 p. 8vo. [n. p.] 1892.

Holden (E. S.) [Policy of its administration.] Pub. Astron. Soc., Pacific, 3: 74. 189[illegible].

Report . . . June 30, 1891. Rept. Sec. U. S. Navy. 1891: 122-31. *Also*, Reprint.

Report . . . 1892. Rept. Sec. U. S. Navy, 1892: 133-40. *Also*, Reprint.

Uranus.

Holden (E. S.) and others. [Observations, 1889-91.] il. Pub. Astron. Soc. Pacific., [illegible] 283. [illegible]91.

Variable Stars.

de Ball (L.) Veränderlichen stern BD + 1°,4359 im Sternbilde Aquarius. Astron. Nachr., 130: 367. 1892.

Chandler (S. C.). Contributions to the knowledge of the inequalities in the periods of the variable stars. Astron. Jour., 11: 14,113, 1891; 11: 121 ,1892.

——. Period of U Orionis. Astron. Jour., 10: 133. 1891.

Dunér (N. C.) Hauptursache der Anomalien im Lichtwechsel von Y Cygni. Astron. Nachr., 129: 313-22. 1892.

——. Chief cause of the anomalies in the light variations of Y Cygni. Astron. Jour., 12: 1, 13. 1892.

Gore (J. E.) Period of U Orionis. Astron. Jour., 10: 174. 1891.

——. Probable distance of Algol. J. Brit. Astron. Assn., 2: 443. 1892.

Variable Stars—Continued.

Plassmann (J.) Wahre Gestalt der Algol-Curve. Astron. Nachr., 128: 437. 1891.

——. True form of Algol's light curve. Astron. and Astrophys., 11: 419–24. 1892.

——. Parkhurst (H. M.) Period of 466 U Piscium. Astron. Jour., 10: 146: 11; 79. 1891.

——. Period of 3567 V. Leonis. Astron. Jour., 11: 126. 1892.

Townley (S. D.) Variable stars of long period. Pub. Astron. Soc. Pacific., 4: 203–13. 1892.

——. Observations of telescopic variable stars of long period. 148 p. 4to. Madison. 1892. (Pub. Washburn Obsry v. 6., pt. 3.

Yendell (P. S.) Note on the elements of some of the more recently discovered variables. Astron. Jour., 12: 89. 1892.

Vatican Observatory.

Cortie (A. L.) Papal brief on astronomy. Obsry., 14: 226–8. 1891.

Publicazioni della Specola Vaticana sotto la direzione di P. Denza. Fasc. 1. 4to. Roma, 1891.

Tarry (H.) [Réorganisation de] l'observatoire du Vatican. L'Astron., 10: 343–9. 1891.

Venus.

Trouvelot (E. L.) Observations sur la planète Vénus. il. L'Astron., 11: 211–23. 1892.

Zona (T.) and Mascari (A.) Observazioni di Venere. il. Astron. Nachr., 131: 121. 1892.

Venus (Diameter of).

Auwers (A.) Sonnendurchmesser und der Venusdurchmesser nach den Beobachtungen an den Heliometern der deutschen Venus-Expeditionen. Astron. Nachr., 128: 361–76. 1891.

Venus (Rotation of).

Bouquet de la Grye (J. J. A.) Rotation de la planète Vénus. L'Astron., 10: 261–8. 1891.

Loschardt (F.) Die neuesten Hypothesen über die Rotation . . . Situngsb. d. k. akad. d. wissensch. Berl. Math. Naturw. cl. bd. 100 Abth. 2: 573–60. Wien, 1891. 24 p. 8vo.

Rev. by Wislicenus (W. F.) Vrtljschr. d. Astron. Gesellsch., 27: 271–302. 1892.

Niesten (L.) À propos de la rotation . . . 18 p. 8vo. Bruxelles, 1891. *Repr. from:* Bull. Acad. Roy. de Belg. 3. s., 21:452–70. 1891.

Rev. by Wislecenus (W. F.) Vrtljschr. d. Astron. Gesellsch, 27:271–302. 1892.

Trouvelot (E. L.) Observations sur la planète Vénus. 84 p 8vo. Par. 1892.

Rev. by Wislicenus (W. F.) Vrtljschr. d. Astron. Gesellsch., 27: 271–302. 1892. Soc. Astron. d. France, 3 Feb., 1892.

Wislicenus (W. F.) [Review of recent publications] Vrtljschr. d. Astron. Gesellsch., 27: 271–302. 1892.

Venus (Transits of).

Updegraff (M.) Elementary method for calculating transits of Venus and Mercury. Sid. Mess., 10: 225–33. 1891.

Washburn Observatory.

Comstock (G. C.) Latitude. Pub. Washburn Observatory, 6: 78–148. 1882. (v. 6, pt. 4.)

Townley (S. D.) Notes from the time service of the Washburn Observatory. Astron. and Astrophys., 11: 467–70. 1892.

West Point Observatory.

Harlow (F. S.) [Description of instruments.] Pub. Astron. Soc. Pacific, 3: 273. 1891.

Yale University Observatory.

REPORT . . . 1890–'91. 23 p. 8vo. [n. p., n. d.]

REPORT . . . 1891–'92. 26 p. 8vo. [n. p., n. d.]

Yerkes Observatory.

HALE (G. E.) [Equipment of] the Yerkes Observatory of the University of Chicago. Astron. and Astrophys., 11: 790–3. 1892.

Zenith Telescope.

JACOBY (H.) Calculation of star places for zenith-telescope observations. Trans. N. Y. Acad. Sc., 10: 86, 1891.

——. Calculation of star places for zenith-telescope observations. Astron. Jour. 10: 172. 1891.

——. Table for weighting zenith-telescope observations. Astron. jour., 11: 142. 1892.

Zodiac.

BROWN (R.) jr. Remarks on the Euphratean astronomical names of the signs of the zodiac. Proc. Soc. Biblical Archæol. 13: 246–71. 1891.

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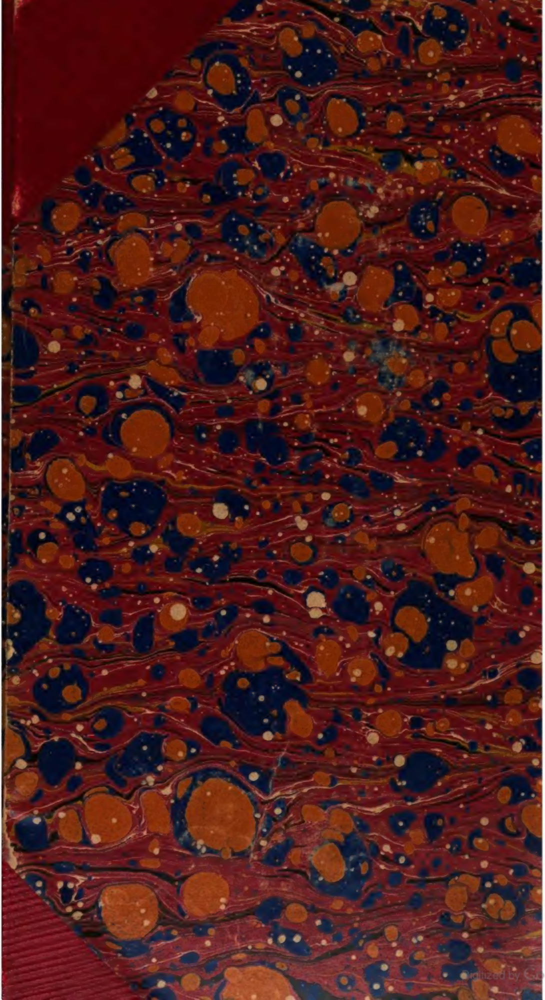UNIVERSITY OF CALIFORNIA, SANTA CRUZ
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